THE DENTAL PRACTITIONER

AND DENTAL RECORD

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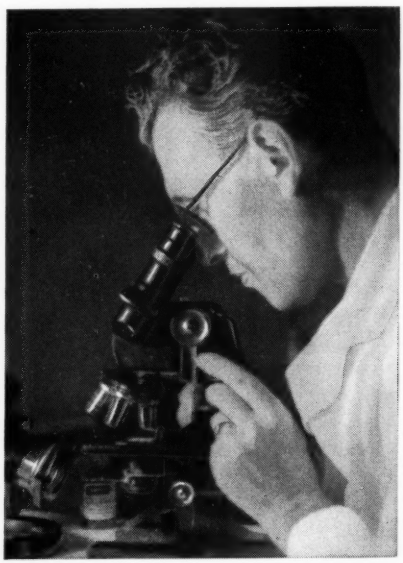

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THE DENTAL PRACTITIONER AND DENTAL RECORD

Vol. IX, No. 7 March, 1959

EDITORIAL

HIGH-SPEED DENTAL ENGINES

For fifty years the dental engine did not change. The profession was satisfied with its performance. What development there was took place in the handpiece and in more efficient burs and stones.

Suddenly, however, little more than ten years ago, a revolution occurred. We witnessed the dramatic speeding up of the rotary drill, achieved through the gearing up of the belt-driven handpiece. This was soon followed by the air and water turbines. The hundred thousand rev. range (as opposed to the three to six thousand) is, to-day, an accepted operational speed for dental engines.

But, inevitably, the new high-speed turbine drills have posed their own new problems. A number of them recur time and again. Among the most important—what of the splash-back from high-speed water jets? Can this annoyance be eliminated?

What of the "oily mist" present during operation? This obscures mirror vision and films the cavity surface, which can cause separation between the filling material and preparation.

Is the elaborate and expensive electrical control really necessary? The Dental Practitioner felt that some of the answers might already be taking shape within the research laboratories and sought the opinion of one of the men now engaged on the future development of the high-speed rotary drill.

Fault in basic design is, in his opinion, the core of the present problems. All of them, he adds, can in time be solved. For instance, the splash-back could be eliminated by diffusing the force of the water jet into a spray. In addition, this would have the advantage of allowing the water—as a cooling agent—to envelop the whole of the cutting instrument rather than one section as at present. It is also agreed that a double spray, from the two ejection points, would overcome the risk of pulpal overheating that occurs to-day when tooth structure obstructs the single jet.

The oil-laden air—the second problem posed—can be exhausted through the back of the handpiece or elsewhere, as it already is in some instruments.

Finally, in the opinion of our informant, the present expensive electrical circuit could be replaced by simple foot-controlled pneumatic valves.

There is the possibility of the three- or four-bladed bur taking over from the six- or eight-bladed types. Greater areas of tooth tissue would thus be cut more easily. On the instrument panel we may well see three handpieces—the present one, a right-angled handpiece, and a straight one—the last two having high-torque and lower-speed turbine motors attached to regular slip joints. These could be the answer to the operator's wish for a complete range of speed.

These, therefore, are some of the ways in which some of to-day's problems might be solved, but other developments are likely also.

ELASTIC IMPRESSION MATERIALS IN CONSERVATIVE DENTISTRY

By C. R. COWELL, B.D.S., F.D.S.
Lecturer in Conservative Dentistry, Royal Dental Hospital, School of Dental Surgery

DURING the last few years there has been a marked increase in the types of elastic impression materials available to the dental profession. This development has produced a radical change in the indirect inlay techniques. It is now possible to reproduce the teeth and their included preparations with an accuracy previously thought to be impossible. This paper attempts to place these new materials in perspective for the practitioner.

THE NON-ELASTIC IMPRESSION

It has been argued that the reproduction of undercut surfaces is not needed for the fabrication of an indirect inlay; which is essentially true. However, the practical difficulty of taking a non-elastic impression remains. It is almost impossible to prevent the material from engaging in the undercuts formed by the natural contours of the tooth. The steps taken to overcome this handicap are well known, but the principles are worth reviewing. The material is enclosed in a rigid copper band, which is shaped so that it rests above the maximum contour of the crown, and extends only to the margins of the cavity. In practice, the band cannot be trimmed accurately enough to extend just to the cavity margins. The junction between the impression material within the cavity and that beyond its margins should therefore be so thin that it will break without causing any distortion of the main impression. This technique has been used by many practitioners who achieve excellent results, overcoming the inherent defects of the material by intelligent and skilful use.

THE ELASTIC IMPRESSION

With the elastic impression materials it is possible to reproduce the whole of the clinical crown, together with the preparation. The accuracy of the reproduction will depend on an intelligent appreciation of the properties of the materials used.

Classification.—At the present time the elastic impression materials can be divided into two main groups: (1) The Hydrocolloids.—This group can be subdivided into a reversible (Agar) and an irreversible (Alginate) type. The term "Hydrocolloid" is now commonly used when referring to the reversible type, whereas irreversible types are known collectively as "Alginates". (2) The Synthetic Rubbers.—This main group can be subdivided into the Thiokol and the Silicone rubbers.

1. The Hydrocolloids.—The hydrocolloids have a water content of 80–85 per cent, a fact which has an important bearing on their behaviour and use. They do not form stable impressions because of their tendency to absorb (imbibition) or lose water (syneresis) when in the set state. This change in water-content is accompanied by a change in dimension, causing distortion of the impression. Unless this basic fact is taken into account by casting the model as soon as possible, inaccuracies will result.

Even when the precaution of storing the impression in a humidor is taken, distortion may occur within 30 minutes (Phillips and Ito, 1951). With alginate bite records, or overall impressions where such accuracy is unnecessary, paraffin oil has been suggested as a suitable storage medium (Morrant and Elphicke, 1956). The water-content of the impression must be taken into account when the model material is considered, as it will react with the surface of the model whilst hardening. The hydrocal plasters (artificial stones) have been found to provide satisfactory models.

Copper-forming of hydrocolloid is possible, but hardly practical for use as a routine laboratory procedure (Dwight, 1949; Hampson, 1952).

Reversible Hydrocolloid.—This material requires heating to change its state from solid (gel) to liquid (sol) and maintain it at a temperature which will not cause discomfort to the patient. Unfortunately these temperatures are close together. The reversible hydrocolloid requires some assistance to speed its cooling whilst in the mouth, and trays have been designed which incorporate a tube through which cold water is passed. It can be seen, therefore, that reversible hydrocolloid is difficult to use, requiring special equipment. Some idea of the procedure can be gained by the temperatures mentioned for various stages of clinical manipulation: Initial softening by boiling; Storage at 145°–150° F.; Cooling at not less than 55° F.; Tempering at 105°–115° F. (Phillips, 1955).

In spite of this, it has been, and is, widely used in North America because of its accuracy. A really dependable, reversible hydrocolloid has not been manufactured in this country, although a formula has been published (Morrant and Makinson, 1954).

Alginates.—The alginates have now been developed to a stage where they are strong and accurate enough to be used for conservative techniques (Skinner and Carlisle, 1956).

They are simpler to use than the reversible hydrocolloids, yet give similar results. However, there is more chance of human error as the final material is the result of a chemical reaction between sodium alginate and calcium sulphate to give the insoluble calcium alginate. The mixing of the alginates and the uniformity of each batch of powder need careful control.

The uniformity of the contents of each tin can only be controlled by the manufacturer. The mixing must be thorough, and the manufacturer's instructions carefully followed. Alginates should be limited to the reproduction of relatively uncomplicated shapes, which will leave the minimum of unsupported material projecting from the bulk of the impression. For example, the alginates will reproduce three-quarter and full veneer crowns satisfactorily, yet fail to record accurately a complex intracoronal cavity.

With the earlier alginates an aqueous fixing solution, 2 per cent potassium sulphate, had to be used on the impression surface to prevent reaction between the impression and the model surface. With most of the modern alginates this is no longer necessary (Phillips and Price, 1955).

Weakness of the Hydrocolloids.—Both of the hydrocolloids are relatively weak when compared to the synthetic rubbers, which can be seen by reference to *Fig.* 1. This means that

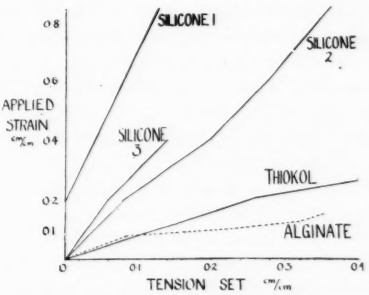

Fig. 1.—The graph indicates the permanent distortion (tension set) which will result when these different elastic impression materials are temporarily distorted (applied strain) and allowed to spring back to their original shape. McLean has estimated that the degree of applied strain to which dental impressions may be subjected is approximately 0·2 cm./cm. From the graph it should be noted that only one silicone rubber recovered its original shape completely when subjected to this strain. The time allowed for setting before these readings were taken was 10 min., which may account for the lack of recovery of the thiokol rubber. The alginate material parted before 0·2 cm./cm. strain could be applied. (*Courtesy of J. H. McLean.*)

they are incapable of reproducing the more severe undercuts, without some distortion. The operator using hydrocolloids is urged to extend the proximal margins of an intracoronal cavity well to the buccal and lingual surfaces (Sturdevant, 1957).

This is to avoid trapping a weak section of material in the proximal region, which may distort or even tear. Withdrawal of the impression from the mouth should be with a sharp motion in the general line of the long axis of the teeth. This has been shown to cause less distortion than the slowly-eased removal (Paffenbarger, 1940).

When the impression has been cast in stone, it should be left to harden with the stone uppermost. Inversion may cause the setting plaster to distort the impression as it is pushed on to the bench surface. The weakness of these materials calls for great care in their use if their extreme accuracy is to be exploited.

2. Synthetic Rubbers.—These materials are chemically different from each other although they have similar physical properties. Neither of them is water based, which gives greater stability when in the set state. Thiokol rubbers are elastomers whose basic molecule contains sulphur; whereas the silicone rubbers are elastomers whose basic molecule contains silicon.

Thiokol Rubbers.—Dental thiokol rubbers are usually formed by the reaction of the polysulphide polymer (thiokol L.P.2) with an activator (lead peroxide).

They are marketed as two pastes: one white containing the polymer, and the other dark brown containing the activator, or accelerator. These pastes are mixed together on a glass or paper surface in the usual ratio of one length brown to two lengths white, until the mix is a uniform brown colour with no streaks of white. The mixing should be accomplished as quickly as possible and the material transferred to the tray without delay for insertion into the mouth. Although an adequate set is not attained for about 6 minutes after mixing, the rubber will rapidly lose its ability to flow. Should the insertion into the mouth be delayed, folds will appear in the impression. It is important that the impression should remain in the mouth for at least 6 minutes, in order that it may reach sufficient strength and elasticity to prevent permanent distortion upon withdrawal. One brand of thiokol rubber marketed in the United States is available in two viscosities. The fluid grade is used for loading the syringe and injecting into the cavity, whereas the thicker grade is loaded into the tray. The viscosity of the impression material will limit the size of the ejection aperture at the syringe nozzle. This will be discussed further in the section on clinical techniques.

Adhesive: An adhesive is available for use with the thiokol rubbers which enables them to be used as a wash, over a trimmed composition impression, without the need of a perforated tray for retention. On the whole, the thiokol rubbers are not very pleasant to use, from the point of view of the operator or the patient. They have an unpleasant odour due to the presence of mercaptan; unless dispensed very carefully they have a tendency to cover both the outside of the tubes and the operator's hands.

Instruments can be cleaned more easily if the rubber is first allowed to harden.

Silicone Rubber.—This is the most recent of the elastic impression materials, and the most expensive. Cold-curing silicone rubbers of this type have only been available commercially since 1954. They are light in colour and pleasant to handle. The rubber is dispensed as a paste (polymer plus fillers) in a collapsible tube, and is cured by the addition of drops of liquid (organo-metallic salt). The manufacturer's instructions indicate how many drops are needed per unit length of paste. Mixing time is the minimum time taken to distribute the curing agent throughout the paste and must be carefully controlled. Some brands of silicone rubber have a coloured curing agent and a white paste. This enables the distribution of the curing agent throughout the paste to be clearly seen. When the colour of the mix is uniform it has been satisfactorily completed.

The material must be inserted into the mouth as soon as the mix has been completed, to avoid the appearance of folds and drags in the final impression. This material, in common with the thiokol rubber, soon loses its ability to flow. Undermixing will leave some paste tacky when the remainder has set to a tough elastic mass. This may occur more frequently when the mixing is carried out in a bowl. Use may be made of two almost simultaneous mixes for the injection technique. The initial mix for the syringe uses two drops less of curing agent than the amount specified by the manufacturers; the second mix, for the tray, uses the correct amount of curing agent. If this technique is attempted with one mix, by adding extra drops of curing

agent after the syringe has been filled, the chances are that folds will appear in the impression.

Although silicone rubber is an excellent material, it is probably capable of further development. The first examples marketed in this country were rather viscous pastes, which had the disadvantage of producing a large quantity of gas from the surface of an impression. This gas would cause porosity of the stone models or the distortion of an electro-deposited film. Leaving the impression for 24 hours before casting, or placing it in a vacuum for 10 minutes, would avoid porous stone models (McLean, 1958). However, with some of the earlier dental silicone rubbers, gas could still be detected after 14 days. They also had a short shelf-life due to a double curing agent, part of which was in the paste. Later modifications of these materials have reduced the gassing, and the model can be poured immediately; but some batches will still cause this trouble. A recent development has been the provision of a less viscous grade of silicone rubber which will allow a smaller ejection aperture to be used in the nozzle of the syringe. However, the accuracy of the more fluid types of silicone rubbers is suspect, as the presence of large amounts of filler is necessary to counteract the shrinkage on curing. They should be cast within one hour, with the model material at mouth temperature (Anderson, 1958).

Toughness of Silicone Rubbers: Although the basic silicone gum is relatively weak, the use of a silica filler has increased the strength of silicone rubbers. The toughness of the silicone rubbers exceeds that of all the other elastic impression materials. This indicates that there is less danger of permanently distorting the impression upon withdrawal. It also enables more than one model to be taken from the same impression, which is a distinct advantage when using the split model technique for the construction of a bridge. The first model is split, and used for the construction of the retainers, while the second model is used for the construction of the bridge. If the models are numbered, it ensures that the wax patterns are taken from the first casting.

MODEL CONSTRUCTION

The model material most frequently used in conjunction with the elastic impression materials is artificial stone, which requires very careful handling by the technician. It is rather brittle, and on the fine edges of reproduced teeth is easily damaged. A thick mix of stone (4 parts powder to 1 part water) is carefully vibrated into the impression in small quantities, so that no air is trapped.

Metal Models and Dies.—If the whole impression is coated with metal, it becomes difficult to gain access to the gingival margins on the interproximal surfaces, or to trim away the reproduced gingivæ on the final model. This mechanical difficulty can be overcome if a method similar to that described by Myers is used, where a heavy metal deposit is only applied to the teeth. The final model has metal plated teeth, which are mounted on dowels and are removable (Myers, 1958). As it requires a great deal of skill and experience to lay down a platinum matrix to a stone die, a metal-formed die is almost essential for the construction of porcelain crowns.

CLINICAL TECHNIQUE

The method of filling a tray with impression material and placing it in the mouth will not give impressions that are sufficiently accurate enough for the construction of inlays and bridges. It will be found that the cervical margins are obliterated, because the impression material has not displaced the gingivæ. The material may also have trapped air within any intracoronal cavities, causing air-bubbles in the final im pression.

The clinical techniques available for use with the elastic impression materials are:—

1. *Injection.*—This uses a syringe to introduce the soft material into all corners of the cavities before the main mass is inserted in a tray. The injection technique can be used with any of the elastic impression materials. The main limiting factor is the viscosity of the material, which determines the size of the injection aperture.

2. *Wash.*—This enables the material to be used as a thin wash over a trimmed composition

impression. As there must be adhesion between the composition and the impression material, this technique is limited at the moment to the thiokol rubbers. For the silicone rubbers an accurately fitting, perforated acrylic special tray can be constructed. The

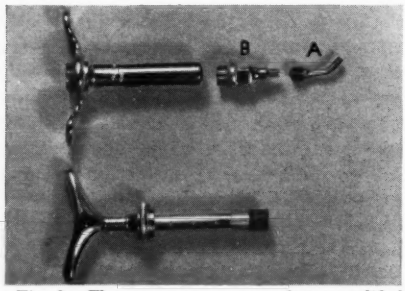

Fig. 2.—The component parts of the modified Dental Manufacturing Co. syringe. A, Tubing soldered to needle hub. B, Terminal section of barrel, with increased lumen.

thickness of the wash can in this way be predetermined.

3. *Copper Ring.*—The band or ring used can be any metal which is not easily distorted upon withdrawal. It is used to take individual impressions of each tooth. Although the ring can be perforated to provide mechanical retention, the additional use of an adhesive is advisable.

The second and third techniques have the disadvantage that the impression material is used in thin section. Any displacement of the material, in order to withdraw the impression, will be a high percentage of its total thickness, and therefore minimize its chances of complete recovery. Few of the elastic materials are capable of 100 per cent recovery to their original shape after distortion. Should a 4 mm. thick section be displaced 1 mm., it represents a distortion of 25 per cent, and its chances of almost complete recovery are better than a 2 mm. section in which the same distortion would represent 50 per cent of the total thickness.

SYRINGES

Several types of syringes are available for use with the elastic impression materials, which may be assessed by consideration of the following features. The whole syringe should be strongly constructed and comfortable to hold in the hand. The nozzles should be interchangable, also long and small enough to be inserted into the depths of any cavity. With the more viscous synthetic rubbers it is a feat of strength to eject them through apertures of less than 1·5 mm. internal diameter, whereas alginate can easily be ejected through a diameter of 1·25 mm. Easy dismantling and cleaning is also essential. A well-designed syringe will enable the loading of the barrel to be carried out rapidly, and have sufficient capacity to cover all the teeth required with one loading.

An "all-metal" hypodermic syringe, modified for use with elastic impression materials, is shown in *Fig.* 2. A piece of orthodontic tubing has been soldered to a needle hub, and the internal lumen increased, where necessary, with a dental bur.

Loading.—With the more viscous pastes the suction method of loading may result in a half-filled barrel. To load from the other end with a spatula is difficult and time-consuming, as the barrel aperture is rather small. However, a short, wide "loading syringe" can be made

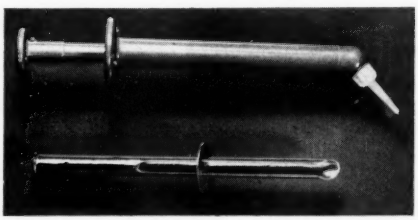

Fig. 3.—A plastic syringe with an open-sided tube for loading. This tube is loaded with a spatula and inserted into the barrel of the syringe. A disk is then used which fits the tube accurately, and retains the impression material in the barrel whilst the open-sided tube is withdrawn.

from a 35 mm. film cassette. Another method of loading is to use a syringe which dismantles to give a split barrel (Derrick, 1956).

A plastic syringe is now marketed using an inner, open-sided, sleeve which is easily loaded and inserted into the barrel. An accurately fitting disk is then used to retain the impression material in the syringe whilst the sleeve is withdrawn. This is shown in *Fig.* 3.

TRAYS

The trays used in conjunction with an injection technique should provide the impression material with firm mechanical retention, and be of strong construction so that distortion will not take place during handling. The use of expanded mesh or perforated metal has been advised for the construction of sectional trays (Myers, Wepfer, and Peyton, 1958). If this metal is capable of being easily bent with the fingers it should be given a firm backing, or distortion may inadvertently occur. Stock trays of the type shown in *Fig.* 5 are suitable for elastic impression techniques. It is preferable to use sectional trays in the lower jaw, as they enable the saliva ejector to remain in position whilst the impression is inserted, keeping the tongue away and the teeth dry.

INJECTION TECHNIQUE

When the preparation has been completed, the gingival crevice must be packed to displace the free gingivæ. A twist of cotton-wool or a length of darning wool dampened with an astringent (8 per cent zinc chloride), or a vasoconstrictor ($\frac{1}{1000}$ adrenaline), is carefully packed between the tooth and the free gingiva with a small plastic instrument (*Fig.* 4).

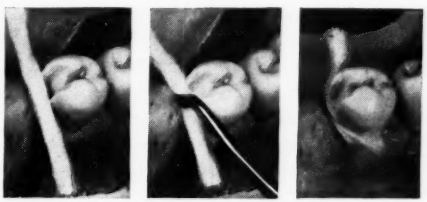

Fig. 4.—Three stages of packing the gingival crevice.

No free zinc chloride should be allowed to flood the surrounding gingivæ and periodontal membrane. This packing must be carried out wherever the margin of the preparation would otherwise be obscured by the gingivæ.

A tray is selected, and provided with composition stops which do not encroach on the area of the prepared teeth (*Fig.* 5). These stops provide a firm foundation for the tray whilst the impression is setting.

When this has been done the teeth should be finally cleaned with 1 per cent cetrimide, and wiped dry. Excessive drying by compressed air will hinder the flow of the impression material over the tooth; whereas if the tooth is allowed to remain too wet, silicone rubber will tend to fall away, especially in the upper jaw.

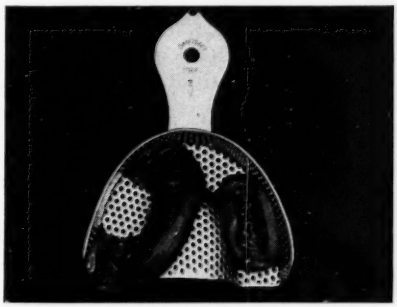

Fig. 5.—A perforated tray with composition stops for taking an impression of the upper left first molar area.

Should any mucus be allowed to remain on the tooth it may not be displaced by the impression material, causing an inaccurate impression to be taken.

The chosen material should then be mixed according to the manufacturer's instructions, or slight modifications of these. A slightly longer manipulation time is required with this technique, which can be gained by using cold water for mixing the alginates, and by using two or three fewer drops of curing agent with the silicone rubbers. The addition of a few drops of oleic acid to thiokol rubbers as a retarder has been suggested (Jorgensen, 1957). Once the mix has been completed it should be transferred to the syringe without delay. The gingival pack is removed and the material injected into all parts of the cavity. The method of injection is to place the syringe nozzle in the deepest part of the cavity and fill it from the depth to the surface, always keeping the nozzle just in the bulk of the material. Any corners where air is likely to

be trapped should be given special attention.

Whilst the material is being injected into the cavities, the chairside assistant will be loading the appropriate section in the tray. This is seated into position in the mouth and firmly held there until the material has set.

SETTING TIME

Alginates.—Although the setting time for alginates is indicated by the manufacturer, it is subject to variation by the room temperature, even though mixed with cold water. The moment for withdrawal can be taken as two minutes after the material has gelled. To leave the impression in the mouth longer than this would lead to a loss of elasticity (Skinner and Pomes, 1947). The change from sol to gel is a fairly sharp one, and can be easily judged by the operator.

Synthetic Rubbers.—The setting point of synthetic rubbers is not so clearly defined as that of alginate. When it seems to the operator that the set has taken place, the rubber may still be relatively weak and subject to permanent distortion upon withdrawal. It is for this reason that rubber impressions are left in the mouth for 6 minutes after insertion. The importance of this, with thiokol rubber especially, can be seen by reference to *Fig.* 1 in which the readings were taken 10 minutes after the commencement of the mix.

Stability of Synthetic Rubbers.—Although the manufacturers suggest that the synthetic rubbers are dimensionally stable for indefinite periods, this is not strictly true. A slight shrinkage occurs (McLean, 1958; Anderson, 1958) which is to be expected from the change in molecular arrangements that takes place. The effects of this shrinkage will be diminished if the impression is retained within a rigid perforated tray. Should the thickness of the rubber be too great in any one place, the support of the tray will have less effect in diminishing the contraction at that point. Ideally, the impression should be cast within 2 hours.

In addition to the shrinkage there may be other permanent distortion due to unresolved stresses within the material.

Both of the synthetic rubbers have a high coefficient of thermal expansion which will also lead to dimensional changes, after the impression has been removed from the mouth (Anderson, 1958; Jorgensen, 1957).

In spite of all the above factors, the elastic impression materials can be used successfully to construct inlays which closely approach those constructed by skilled operators using direct techniques.

CONTRA-INDICATIONS TO THE INJECTION TECHNIQUE

Occasionally difficulty will be experienced when using the above technique. For example, when recording a lower third molar, the access is difficult, and the tongue tends to sweep the injected material from the teeth before it can be covered with the tray. If this is the case, a copper ring impression should be attempted. The hydrocolloids are too weak to be used in thin section, as required in the following techniques. Although the viscosity and poor flow of the silicone rubbers is not a contra-indication to their use with an injecting technique, it does remain rather difficult to obtain an impression, in this material, which is completely blemish free.

COPPER-RING TECHNIQUE

Thiokol rubber is really the only material at present suitable for this technique, although silicone rubbers can be used. The ring should be rigid to prevent distortion upon withdrawal. It should fit the tooth loosely, but not so loosely that it will entrap the gingivæ instead of displacing it. The gingival end of the ring should then be contoured so that it follows the gingival margin and not the maximum contour of the crown. It may be necessary to contour the ring so that it passes over and not through a tight contact point. A roof is provided for the ring with composition as shown in *Fig.* 6, so that the elastic impression material will be forced into every corner of the preparation. Perforations are then made in the ring to provide mechanical retention; the inside is coated with adhesive, and then it is placed to one side. Ready-made aluminium crown forms can be used for this

purpose, but they are weak and easily distorted. The thiokol rubber is mixed, loaded into the ring, and the ring seated into place on the tooth.

Once in place it should be firmly held for at least 5 minutes.

An overall impression is then taken in a perforated tray over the copper rings. After 6 minutes the two impressions are withdrawn

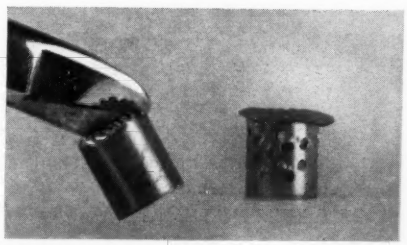

Fig. 6.—The preparation of a perforated copper ring for a silicone rubber multiple abutment impression.

in one piece. The above technique is also suitable for the construction of a tooth-borne denture with precision rests, when single-stage injection would be almost impossible. The impression material for the overall impression need not be of the same material as that within the copper ring.

WASH TECHNIQUE

As the use of an adhesive is necessary to provide retention of the elastic "wash" in this technique, only thiokol rubber is a suitable material. The lack of an adhesive for silicone rubber makes the use of this material, in a thin wash, hazardous. A special tray of perforated acrylic can be constructed from a primary impression, for use with silicone rubber.

For this technique an impression of the section required is taken in a non-elastic composition, which is eased from the mouth before it has set quite hard. This first impression is then cooled, and trimmed with a scalpel or bur so that a clearance of 2–3 mm. is made to accommodate the rubber, especially in the gingival region. Following this the trimmed impression is cleaned, dried, and coated with a thin layer of the adhesive, then placed to one side. The teeth should be clean, but not dry, for this technique to promote flow of the rubber. It is not wise to trust that the gingivæ will be forced away from the teeth by the rubber, and gingival packing should be carried out as for the injection technique.

The recess in the composition is then filled with freshly mixed thiokol rubber and seated

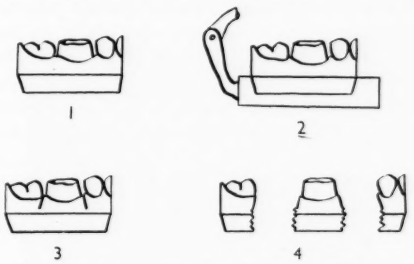

Fig. 7.—Diagram showing the preparation of a "stone" model for indirect work. 1, Base of the model trimmed before inserting into a plaster key; 2, Petroleum jellied model inserted into plaster key on articulator; 3, Model removed from key. Saw cuts made on either side of the prepared tooth; 4, Model fractured into sections by a sharp tap with a small hammer on the base. The gingival margin of the preparation is exposed by careful trimming with a scalpel, before reinserting into the key.

on the teeth, after removal of gingival packs. The tray is held steady for 6 minutes before it is withdrawn. Excess rubber should appear at the margins of the tray when it is correctly in position.

For accurate occlusion records it is advisable to take elastic impressions of the opposing teeth, together with a squash bite. Both of these can be combined in the one stage, by placing a mass of alginate or rubber between the teeth, supported by two perforated side plates which are connected by a thin bar which passes behind the maxillary tuberosity (Getz, 1953).

LABORATORY TECHNIQUE

A stone model is made which is trimmed, fitted into a plaster key, and articulated. The model is then parted from the key and saw cuts are made interproximally between the prepared and adjacent teeth for two-thirds of the model thickness. The remaining thickness

is then fractured by a sharp blow with a small hammer on the reverse surface (*Fig.* 7). Each section is then trimmed with a sharp scalpel, so that the entire margin of the preparation is easily accessible. Immersion of each section in thin oil for 15 minutes, which is then drained and wiped off, will prevent the inlay wax from sticking to the model. Contact points can be assessed by the reinsertion of the sectioned model into the plaster key, with the wax patterns or inlays in place. It must be remembered that the line of insertion of the inlay must still be taken into consideration when the contact points are being completed. An excellent technique, using multiple dowels and tubes, has been described (Kinghorn and Allen, 1957). This enables the individual units to be withdrawn from the model without breaking the base.

POSSIBLE DEVELOPMENTS

Elastic impression materials have by no means reached the ultimate, in the reproduction of teeth; they each have disadvantages which may in the future be overcome. It is possible that the water-based impression materials will eventually be discarded in favour of some form of elastomer.

Alginate is an extremely simple material to use, but, unfortunately, it lacks sufficient strength to be applied in every case.

The silicone rubbers are at the other end of the scale, being tough, accurate, and strong. More skill is, however, needed to produce a blemish-free impression with these materials. It may be possible eventually to apply the first layer to the teeth in the form of a spray, which would cover all surfaces evenly without trapping air. The second stage, of covering this first layer with a more viscous mass in a tray, would present no problem. They are usually limited to use with an injection technique, a perforated metal ring, or a specially constructed perforated tray, because of the lack of an adequate adhesive. Adhesives for use with silicone rubbers are available, but are too slow in action for clinical techniques.

Both of the synthetic rubbers have a high coefficient of thermal expansion, which might be of use in controlling the size of the final model to finer limits.

Model materials used at the moment are satisfactory but hardly ideal. A substance is required which is as easy to handle as stone, yet will give a harder, tougher surface. Perhaps further developments in the field of plastics will produce such a material. The epoxy resins or the isocyanates may provide the answer. When the ideal model material is found, it may be of sufficient accuracy, appearance, toughness, and strength to replace the gold inlay in the restoration of teeth.

SUMMARY

In this paper the classification of the elastic impression materials has been attempted, together with a summary of their more important clinical features. Three clinical techniques have been briefly described, and the laboratory procedure indicated.

Acknowledgements.—The writer wishes to thank Mr. Shilland, of the Photographic Department, Royal Dental Hospital, for his help, also Mr. Davies, of the Materials Department, Eastman Dental Hospital, for the original graph from which the diagram in *Fig.* 1 was prepared.

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PATHOLOGY OF THE INTERDENTAL TISSUES*

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REDUCED to its simplest essentials, periodontal disease is a breakdown of the tooth-supporting tissues which, for practical purposes, are three in number—the bone which forms the socket, the periodontal fibres which attach the tooth to its surrounding structures, and the epithelium which forms the covering by which these structures are insulated from the outer environment. When the destruction of these tissues is studied histologically, it is found that although bone changes are seen only in advanced cases, epithelial ulceration and loss of periodontal fibres are extremely frequent findings. It is, in fact, sometimes difficult to find histological sections of periodontal tissues which can be deemed completely free from pathological change. This does not mean that such tissues are not clinically healthy, for disease can be detected at a microscopical level long before signs can be seen in the mouth. In other respects, however, there are certain disadvantages attached to microscopical examination. In the first place the disease process should be recognized as a dynamic one, subject to continual alteration and modification, and histological sections can only depict a fixed and static phase. This disadvantage can be offset by studying large numbers of specimens so that sampling error is avoided as far as is possible. This necessity introduces a second difficulty because the type of material required is not easily obtained. Autopsy material is often unsatisfactory on account of poor fixation, and if the early stages of most diseases are to be traced it is necessary to study changes in young subjects. This generalization may, indeed, prove to be particularly applicable in the case of periodontal disease.

Fig. 1.—Retromolar papilla in rat. H. and E. (× 75.)

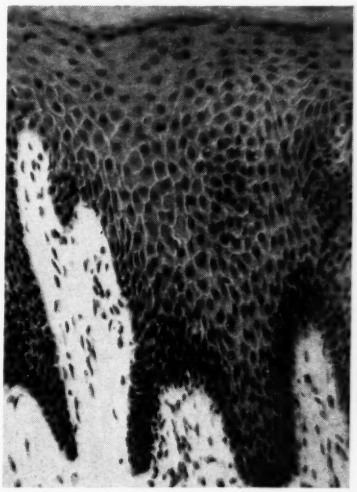

Fig. 2.—Section of human gingiva to illustrate normal architecture and maturation. H. and E. (× 150.)

In order to supplement the available human material, studies were made on tissues

* Paper delivered at the meeting of the British Society of Periodontology held on November 10, 1958.

from laboratory rats and from monkeys. Several authors have studied periodontal disease in hamsters and it has been found in the course of the present investigation that the incidence of the disease is comparably high in rats. The monkeys used (*Macacus irus*) were all in the mixed dentition period and their tissues were fixed at the time of death.

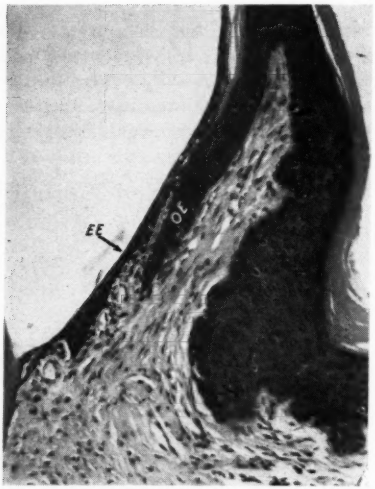

Fig. 3.—Papilla posterior to second molar in rat showing oral epithelium (OE) proliferating beneath reduced enamel epithelium (EE). H. and E. (× 135.)

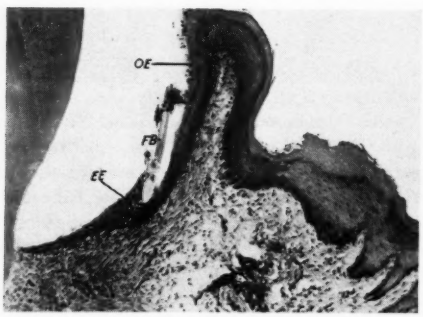

Fig. 4.—Retromolar papilla in rat. A spear-shaped foreign body (FB) has passed over the keratinized surface of the oral epithelium (OE) and penetrated the non-keratinized enamel epithelium (EE). The embedded fragment is seen in later serials at a site corresponding to the location of inflammatory cells under the enamel epithelium in this illustration. H. and E. (× 56.)

Histological examination of the tissues surrounding a tooth reveals a striking difference between the epithelium covering the oral mucosa and that which lies in contact with the tooth (*Fig.* 1). The oral mucosa is covered by typical stratified squamous epithelium. Its thickness, compared to that of the epithelium in contact with the tooth, is considerable. Its deepest layers are arranged, not as a flat band, but in the form of irregular prolongations known as rete pegs, and its surface is composed of a virtually homogeneous scale of keratin (*Fig.* 2). None of these features is seen in the epithelium adjacent to the teeth, although at first glance it may appear to be an integral extension of the oral mucosa.

The reason for the discrepancy is, of course, that these are, in fact, two separate and distinct epithelia. The cells which lie adjacent to the tooth differ in appearance from the stratified squamous epithelium of the mucosa for the reason that they are not oral epithelium proper but merely the remains of the enamel organ—the result of a fusion between the inner and outer enamel epithelia. Difficulty in appreciating that a gingival surface can be composed of enamel epithelium could arise from thinking that an erupting tooth penetrates the oral epithelium and should therefore perforce be surrounded by oral

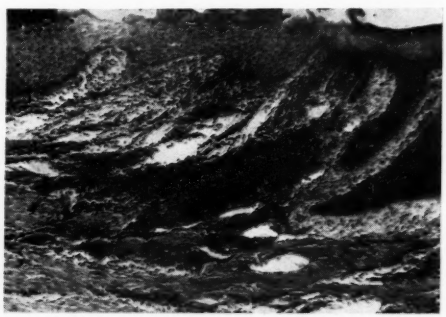

Fig. 5.—Buccolingual section from between molars of a man, aged 34, to show the distribution of inflammatory cells beneath the non-keratinized epithelium. H. and E. (× 45.)

epithelium. This, however, is an over-simplification, for two other factors have to be taken into consideration: the first is that the erupting tooth is itself covered by a coat of epithelium (the reduced epithelium of the enamel organ), and the second that complete eruption is a slow process, taking place over many months, and not a quick piercing penetration.

In any consideration of pathological changes in the periodontal tissues it should be appreciated that the difference between these two epithelia is more than merely a difference in appearance. Oral epithelium is a proliferating tissue showing all the features characteristic of growing stratified squamous epithelium, from the mitotic activity seen in the basal layer, to the end-result of a keratinous superficial surface (*Fig.* 2). A second proliferative capacity of this epithelium is that which is concerned in wound healing. Just as friction is a stimulus encouraging the maturation of cells to form keratin, so any breach in continuity acts as a tremendous impetus towards lateral proliferation of the basal layer. One might describe these cells as characteristically gregarious, for if the epithelium should be divided or breached the reaction is active proliferation at the severed ends until continuity is re-established. A foremost factor governing the activity of these cells is their mutual relationship. This has been demonstrated in tissue culture by observing that growth outward from two explants ceases abruptly as soon as contact is made.

When these two epithelia are examined side by side (*Fig.* 3) the oral epithelium is seen to possess a rich potential for expansive as well as maturing proliferation. The enamel epithelium, by contrast, shows little evidence of possessing either potential. Both in appearance and in the light of theoretical considerations it seems to be a degenerating tissue, a relic of the more stirring days of amelogenesis and, ostensibly, doomed to extinction by the time the gingiva has receded to the level of the cement-enamel junction.

Whereas, therefore, the oral epithelium admirably fulfils a protective function by presenting a thick and often horny coat to potentially injurious elements, the enamel epithelium, because it is not actively growing and therefore not actively keratinizing, is capable of far less resistance to foreign material. In the laboratory rat, inflammatory changes in the periodontium are frequently complicated by the impaction in the subepithelial tissues of food debris; and this impaction can most often be correlated with the distribution of these two types of epithelium, that is with the presence or absence of surface keratin (*Fig.* 4).

In human material, too, many examples can be found to illustrate the relatively greater resistance of keratinized surfaces to external injury. *Fig.* 5 provides a typical example showing a concentration of inflammatory cells underlying an area of non-keratinized epithelium; by contrast, the corium beneath the adjacent keratinized surface is relatively free of inflammatory cells. This, of course, is in accord with the reasoning which led to the adoption of frictional stimulation as a means of therapy. This aspect need be dealt with no further at present, other than to say that there can be no point in instituting such treatment unless the epithelium subject to friction is capable of becoming keratinized.

It therefore becomes necessary to study the distribution of the two epithelia in order to determine the sites of greatest vulnerability. A common feature, seen in histological preparations, is the appearance of inflammatory cells in the area underlying the junction of the oral and enamel epithelia (*see Fig.* 3). This was recognized by Warwick James and Counsell in 1927. They described a projection of epithelium which they called the "tag" and which they regarded as the zone of injury because of the frequency with which they noted inflammatory cells underlying the area. The tag corresponds to the spur of necrotic enamel epithelium overlying the point at which proliferating gingival epithelium is brought to a halt. The reason for the existence of this spur is that the oral epithelium and the enamel epithelium do not come together end to end and simply unite; instead, the oral epithelium undermines the enamel epithelium for a short distance until it reaches an intact portion, at

which point its further proliferation appears to be temporarily arrested.

The reason for the vulnerability of this aptly termed zone of injury is not entirely clear. It is possible that the confluence of the oral and enamel epithelia fails to provide an impervious seal. It is also possible that the oral epithelium lags a little behind the rate of degeneration of the enamel epithelium which it is replacing and so allows the seepage of foreign matter into the underlying tissues. Thirdly, it is possible that the zone of injury merely reflects the inability of the enamel epithelium to serve the needs of an outer protective covering, and the concentration of inflammatory cells is explicable by the fact that this is the area of enamel epithelium closest to the surface.

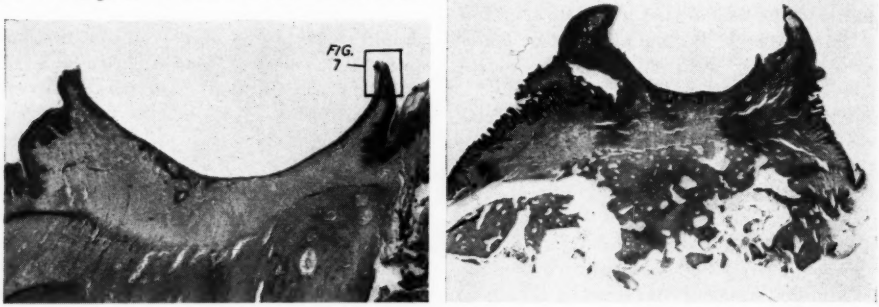

Fig. 6.—A, Buccolingual section between rat molars from which the talon cusp has been removed, to illustrate the shape of a col. The distinction between the two epithelia is apparent in a higher magnification of the area of their confluence, seen in *Fig.* 7. H. and E. (× 40.) B, Human infant, aged 2½ years. Buccolingual section to illustrate the shape of a col between the two molars. H. and E. (× 7·5.)

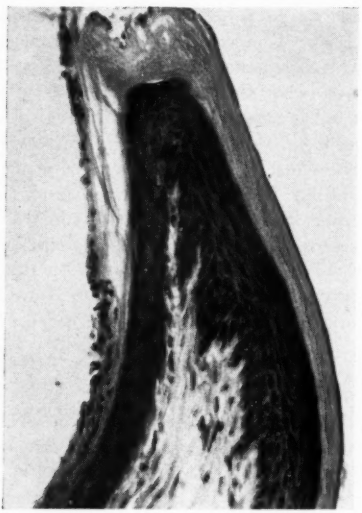

Fig. 7.—Higher magnification of the area of epithelial confluence shown in *Fig.* 6 A. H. and E. (× 225.)

It is noteworthy that in numerous instances aggregations of inflammatory cells and even areas of destruction of periodontal fibres are found without histological evidence of frank ulceration. Perhaps as a consequence of this the belief is commonly held that the presence of inflammatory cells in the dermis should be regarded as normal, a view which would seem opposed to established principles of pathology; the presence of subepidermal inflammatory cells should rather be regarded as an indication of a breach, however minor, in the epithelial integrity. It is understandable that in many instances the area of ulceration may not be evident on the section studied and that serial sections may be necessary in order to identify the exact breach.

In pursuit of the possibility that inadequacy of the enamel epithelium could explain the existence of foci of subepithelial inflammation, an attempt was made to define the site of areas not covered by stratified squamous epithelium. The zone of injury described

by James and Counsell is demonstrable in mesiodistal sections, but in addition to this approach sections were cut in a buccolingual plane. It was found that the interdental gingival septum has a concave outline; the two highest points are the buccal and lingual papillæ, and between them there is a considerable depression which varies in depth according to the height of the two peripheral peaks, that is, according to the degree of gingival recession which has taken place. The shape of this septum is, indeed, exactly what might be expected if a plastic substance were squeezed into the embrasures on each side of the contact point and beneath it. It is a shape corresponding to the topographical feature referred to as a col by mountaineers, and this term will therefore be used to describe an interdental septum of this shape (*Fig.* 6). It was observed that in the case of newly-erupted teeth an extensive area of the col was covered by enamel epithelium and not by the stratified squamous variety (*Fig.* 7).

This observation could provide a missing link in the chain of evidence implicating epithelial inadequacy. The area of enamel epithelium is far more extensive than that seen at James and Counsell's zone of injury and, unlike the latter situation, squamous epithelium capable of rapid proliferation is not immediately adjacent to repair any breach that occurs in the surface.

In order to explain the development of the col, it is necessary to consider the events associated with the eruption of a tooth into an arch. In most instances an erupting tooth, as it assumes its position in the arch, abuts closely against one already erupted. As contact with such an adjacent tooth is achieved the erupting tooth undermines the bridge of oral mucosa which can be seen between the peak of its first emerging cusp and the neighbouring tooth. The undermined bridge of oral epithelium, robbed of the corium upon which it depends for its nourishment, becomes severed and its ends remain as the buccal and lingual papillæ. Between these two papillæ only reduced enamel epithelium persists.

The key to the development of periodontal disease in young subjects may well lie in this severance in the continuity of gingival epithelium at the time of tooth eruption, an occurrence which clinicians will recognize as

Fig. 8.—Human col covered by stratified squamous epithelium. From an apparently healthy septum between premolars in a male aged 41. H. and E. (× 9.)

frequent but not invariable. From the moment of this happening the entire area underlying the col is in jeopardy. For although it is true that epithelium in this situation is not called upon to withstand many of the rigours of masticatory stress, the more significant fact is that in many instances it would not appear to be impermeable to fluid. There could thus arise a situation in which connective tissues may be directly exposed to external influences.

Adequate protection of the interdental fibres, and the alveolar bone beneath them, can only be achieved by oral epithelium growing through the space beneath the contact point until the buccal and lingual papillæ are reunited. In many sections taken from specimens of adults in whom no periodontal disease was evident the col was found to be covered by a continuous sheet of stratified squamous epithelium extending unbroken from papilla to papilla (*Fig.* 8). Before the reunion of the two papillæ can be achieved, however, a considerable period must elapse, for severance occurs soon after the crown of the erupting tooth emerges and proliferation beneath the contact point can scarcely

commence until the tooth has erupted into occlusion. In the meantime the only epithelium covering the col is constituted by the reduced

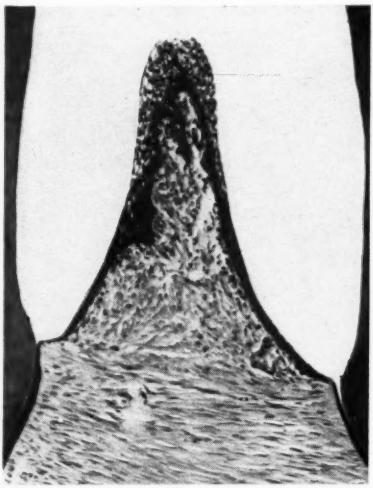

Fig. 9.—Interdental septum of rat. Mesiodistal plane. H. and E. (× 105.)

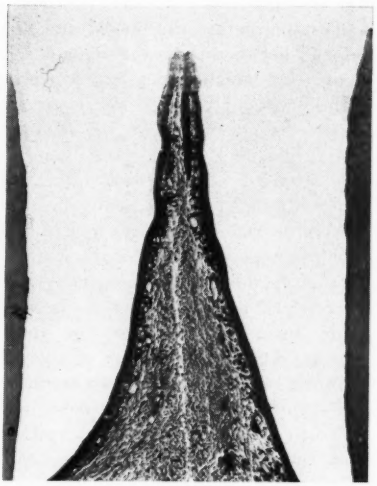

Fig. 10.—Interdental septum of monkey. Mesiodistal plane. H. and E. (× 48.)

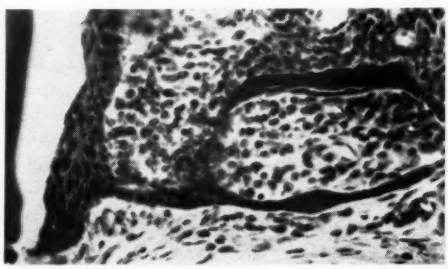

Fig. 11.—From interdental septum of monkey. Mesiodistal plane. Showing typical longitudinal proliferation of enamel epithelium. H. and E. (× 168.)

enamel epithelium covering the two teeth concerned. These two epithelia lie back to back, and although mesiodistal sections often indicate that they fuse together (*Fig.* 9), it is probable that their union would be easily disrupted (as appears to be the case in *Fig.* 10) perhaps by the mere movement of one tooth against the other.

Whatever the mechanism by which the epithelium is breached, the effect is to expose the underlying fibres and subsequently the alveolar bone to contamination. Apart from its primary weakness as a protective integument, for which purpose it lacks both thickness and keratin, enamel epithelium appears to have

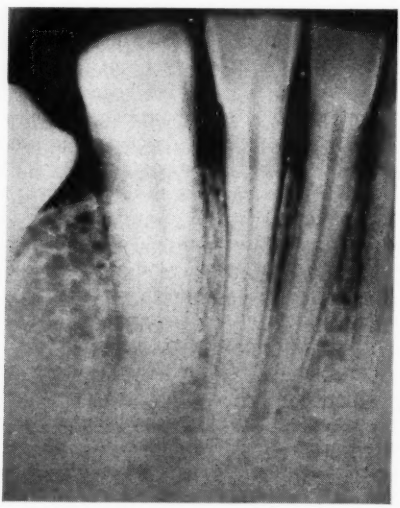

Fig. 12.—X-ray of $\overline{321|}$ region.

no capacity for repair. The pattern of proliferation seems to follow the form of elongated sprouts, usually no more than a cell or two in width, and apparently projecting towards the tooth eruption it is difficult to believe that normal epithelialization of the col could subsequently be achieved by natural processes. This may explain why periodontal disease developed in adolescence or early adult life has such a poor prognosis.

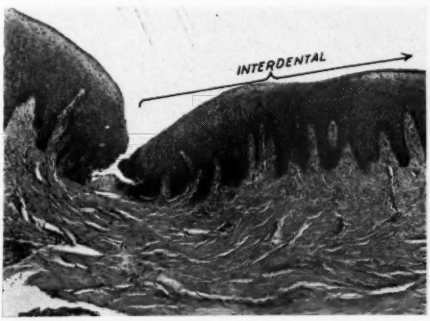

Fig. 13.—Biopsy from space between $\overline{3}|$ and $\overline{2}|$. Showing stratified squamous epithelium covering the interdental septum in continuity with that of the labial papilla. H. and E. (× 39.)

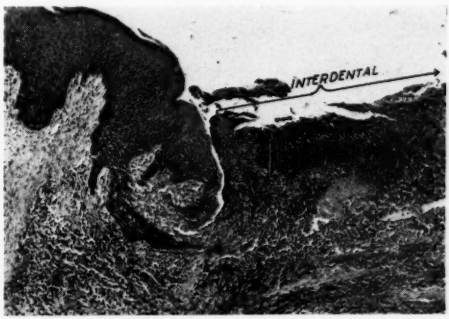

Fig. 14.—Biopsy from space between $\overline{2}|$ and $\overline{1}|$. Showing failure of stratified squamous epithelium covering labial papilla to extend interdentally; the col area is ulcerated and inflamed. H. and E. (× 52.)

stimulus of an underlying area of inflammation (*Fig.* 11). No evidence has been found to suggest that uncomplicated healing or ulcerated enamel epithelium can occur.

This lack of any healing reaction in enamel epithelium suggests the possibility that interdental ulceration may be initiated during the critical period when the security of the entire periodontium waits upon the successful reunion of the buccal and lingual papillæ. A clinical illustration of interdental ulceration was provided by a female patient, aged 25 years, who complained of bleeding gums and halitosis. An X-ray (*Fig.* 12) illustrates the relationship of the right lower anterior teeth. The labial papillæ between $\overline{1}|$ and $\overline{2}|$ bled freely at the slight touch of a blunt probe, while that between $\overline{2}|$ and $\overline{3}|$ appeared to be healthy. Biopsy specimens (*Figs.* 13 and 14) showed that stratified squamous epithelium was continuous from labial to lingual papilla across the col in the case of the healthy diastema, whereas between the $\overline{1}|$ and $\overline{2}|$ the col was not covered by stratified squamous epithelium which ceased abruptly at the margin of papilla and col. If such ulceration were to develop in the period immediately following

This study has not progressed sufficiently far for firm clinical conclusions to be drawn. It would appear likely, however, that:—

1. The time of greatest potential peril to the periodontium is in the period following eruption of permanent teeth in close contact to one another.

2. That this danger becomes considerably lessened once oral epithelium has grown through to cover the col, and recedes still further in middle age.

3. That clinical examination of the interdental papillæ *in adolescents* is of the greatest importance in the prevention of periodontal disease.

4. That preventive measures in young subjects should be directed towards facilitating and expediting the growth of gingival epithelium through the interdental space.

Acknowledgements.—I am grateful to Sir Wilfred Fish for his generous help and guidance; and to Mr. E. B. Brain for the photomicrographs.

CARTILAGE IN A FIBROUS EPULIS

By **B. G. RADDEN**, B.D.Sc. (W. Aust.), F.D.S. R.C.S. (Eng.)
Department of Dental Pathology, The London Hospital Medical College

THE fibrous epulis is an inflammatory hyperplasia arising from the gingiva as a result of some form of local irritation. Calcification or ossification may occur within the lesion, and although Stones (1954) considers this is less common in the true fibrous epulis than in the giant cell epulis or in the fibroma, Cooke (1952) found some degree of bone formation was present in 20 of his series of 72 fibrous epulides.

The present case of a fibrous epulis is reported because, in addition to ossification, cartilage formation has also occurred.

CASE REPORT

A man of 43 was referred to the London Hospital with a lump on the lower right jaw. It had first appeared as a soft painless swelling 10 years previously, and had grown steadily, becoming progressively harder.

Clinical examination revealed a hard ovoid lump firmly attached to the lingual aspect of the mandible. It was covered with apparently normal mucosa and it was difficult to determine the size of its attachment (*Fig.* 1).

X-ray examination revealed that the centre of the mass consisted of a radio-opaque material similar to cancellous bone, which was continuous with the alveolar bone in the region of the missing lower right first permanent molar (*Fig.* 2). Clinical investigation, including blood counts and blood chemistry, revealed no other abnormalities.

Fig. 1.—The swelling on the lingual aspect of the right lower alveolar process.

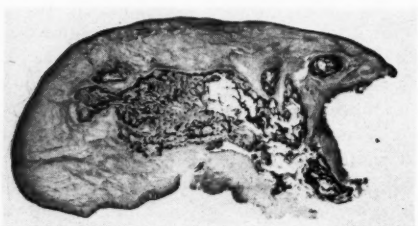

Fig. 3.—A section of the epulis with its clearly defined central core of bone. (Iron-lithium hæmatoxylin and eosin stain.) (Approx. × 1·5).

Fig. 2.—An occlusal radiograph of the swelling, with a central radio-opaque mass.

Following excision of the mass, healing was uneventful.

DESCRIPTION OF SPECIMEN.—The specimen was a hard, flattened, ovoid, whitish mass (4·2 × 3·4 × 2·5 cm.) covered with smooth mucosa. On one surface there was a circular area representing the cut pedicle (2·0 cm. max. diam.) which was granular and gritty to touch.

Following decalcification, the cut surface of the mass showed a central granular brownish oval zone (2·5 × 1·3 cm.) extending from the cut pedicle. The remainder of the surface was marked by a series of thin interlacing bands stretching towards the external surface.

HISTOLOGY.—The upper surface was covered by well keratinized stratified squamous epithelium, whilst non-keratinized stratified squamous epithelium covered the under surface. The corium of this under surface showed a chronic inflammatory infiltration.

The body of the mass was composed of loosely arranged collagen bundles, in a relatively avascular mature stroma with little inflammatory reaction. A central core of bone was present, consisting of lamellar bone containing a fatty marrow surrounded by woven bone (*Fig.* 3). Whilst there were some areas of bony deposition, there was little evidence of bone resorption.

There were several areas of well differentiated cartilage, showing active peripheral ossification (*Fig.* 4). Some of

this ossifying cartilage was incorporated within the central bony core, and resembled endochondral ossification, but there were isolated areas of cartilage showing little evidence of peripheral ossification. The cartilage was hyaline in type, with basophilic intercellular substance predominating (*Fig.* 5). Chondrocytes occurred singly, and in groups within spaces in the matrix, but there were some spaces which contained no cells.

DISCUSSION

This is a fibrous epulis containing bone and cartilage, and although calcification and ossification have been reported as occurring in the fibrous epulis, examination of the literature has revealed no reference to the presence of cartilage within such a lesion. However, Willis (1953) has reported a case of a subcutaneous fibroma containing cartilage.

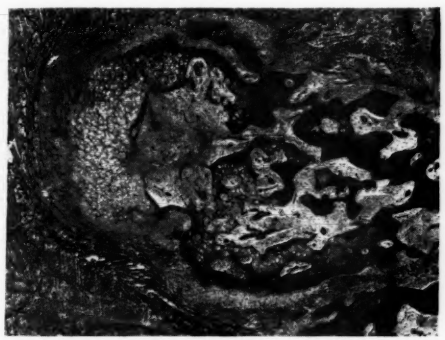

Fig. 4.—The edge of the central core of bone containing an area of cartilage. The inner margins of the cartilage show some peripheral ossification. (Heidenhain's azan stain.) (Approx. × 13.)

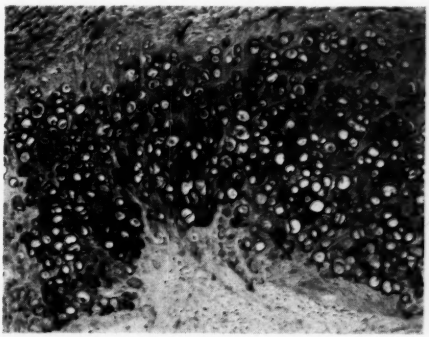

Fig. 5.—A typical area of one of the islands of cartilage. (Dominici's stain.) (Approx. × 50.)

Cooke (1952) considers that, as the fibrous epulis arises from the parosteal tissues of the alveolar process which possess great osteogenic potentialities, the proliferation of undifferentiated mesenchyme cells produces fibroblasts and sometimes osteoblasts, and these in turn produce bone. It would seem reasonable to suggest that in this case the mesenchyme cells have differentiated into chondroblasts, and have the produced cartilage.

The other possible mechanism by which cartilage may have appeared is through metaplastic change. Willis (1950) defines metaplasia as "the transformation of proliferating cells of one kind into cells of another kind under pathological conditions", and he includes amongst his examples of metaplasia "fibroblasts into cartilage". One of the most common conditions under which metaplasia occurs is chronic irritation and inflammation, the conditions which could have caused the epulis itself.

SUMMARY

A fibrous epulis is reported in which cartilage formation, as well as ossification, has occurred. Two suggestions are advanced as possible processes by which the cartilage may have formed: (1) differentiation of chondroblasts from undifferentiated mesenchyme cells of the alveolar process and (2) metaplasia of fibroblasts into cartilage.

Acknowledgements.—I wish to thank Mr. A. G. Allen, Consultant Dental Surgeon, for his permission to report this case, Mr. J. Linder for his help in the preparation of the sections, and Mr. J. King for the photomicrographs.

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THREE CASES OF DISTURBANCE OF CALCIFICATION OF A TOOTH AND INFECTION OF THE DENTAL PULP FOLLOWING TRAUMA

By **W. E. HERBERT**, F.D.S., M.R.C.S., L.R.C.P.
Dental Department, Guy's Hospital

CASE REPORTS

Case 1. D. J., aged 13 years. Received a blow on the deciduous upper incisors when 5 years of age. The $\underline{1}|$ erupted normally, but a sinus developed when the patient was aged 13. Radiographs (*Fig.* 1) showed a very wide root-canal with closed apex. The shadow of a supernumerary tooth was superimposed over the apex of the $\underline{1}|$.

The root-canal was treated with dressings of "Kri" paste and subsequently filled.

Fig. 1.—D. J., aged 13 years. Radiograph showing large pulp chamber in $\underline{1}|$ following injury when 5 years of age, also supernumerary tooth in relation to apex of $\underline{1}|$.

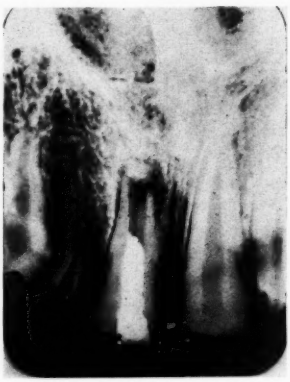

Fig. 2.—J. V., aged 12 years. Radiograph showing periapical infection of $\underline{1}|$ and irregular calcification following injury when 8 years of age.

Fig. 3.—Radiograph of $\underline{1}|$ shown in *Fig.* 2, 5 years after treatment.

Case 2. J. V., aged 12 years. Had a bicycle accident when 8 years of age, as a result of which the crown of $\underline{1}|$ was fractured. Pain was felt immediately following the accident but not afterwards. Three years later the patient visited his dental surgeon complaining of a discharging sinus in the buccal sulcus overlying $\underline{1}|$. Radiographic examination showed that there was rarefaction of bone at the apex of $\underline{1}|$, which was widely open. The pulp chamber was opened and allowed to drain and later a dressing of oil of cloves was inserted. The patient was referred to Guy's Hospital with the suggestion that a root resection might be done under a general anæsthetic as the patient was considered too young and nervous for the operation to be done under a local anæsthetic.

Further radiographic examination (*Fig.* 2) showed that the root of the $\underline{1}|$ was incomplete and the pulp chamber large, suggesting death of the pulp at the age of 8 years. There was a radiolucent area at the apex and also an irregular area of calcification. The root-canal was treated with polyantibiotic paste and the coronal part filled with zinc oxide and oil of cloves. Radiographs 2 years and 5 years later (*Fig.* 3) showed the bone structure in the region of the apex to be normal and also the periodontal membrane shadow.

The root-canal appears to be completely closed, and the tooth has remained symptomless.

Case 3. G. E., aged 15 years. Attended Guy's Hospital, and gave a history of having fallen upstairs at the age of 6 years and damaged her front teeth.

On examination the $\underline{1}|\underline{1}^{2}$ gave no response to thermal changes. Radiographs (*Fig.* 4) showed the pulp of the $\underline{1}|$ to be completely calcified, both centrals to be free of periapical infection whilst the $\underline{1}^{2}$ showed arrested development and periapical infection.

The root-canals of the $\underline{1}|$ and $\underline{1}^{2}$ were treated with polyantibiotic paste (Grossman's formula) on two occasions prior to filling.

COMMENT

1. In the first case the injury has been sufficiently severe to interfere seriously with calcification. The tissues have, however,

partially recovered and the outline of the root is calcified and of normal shape. The pulp which shows as an abnormally large shadow in the radiograph has subsequently died and become infected.

The conservative treatment of such cases presents considerable difficulty and is often unsuccessful. Root-canal treatment, followed by a root resection, leaves a very short root with a very large area of filling material at the apical end which is not as favourable for periapical healing as is dentine. If root-canal treatment without root resection is undertaken it is very difficult to be sure of filling the root-canal evenly to the optimum level.

Fig. 4.—G. E., aged 15 years. Radiograph showing calcification of the pulp of $\underline{1}|1$ and arrested development and periapical infection of $\underline{2}|2$ following injury when 6 years of age.

Fig. 5.—Radiograph of $\underline{2}|2$ shown in *Fig.* 4, 6 months after treatment.

Fig. 6.—Radiograph of $\underline{2}|2$ shown in *Fig.* 4, 4 years after treatment.

2. In the second case calcification has been completely arrested by the injury and a separate mass of calcific material has formed in the periapical region. The pulp has become infected and the calcific mass is shown on the radiograph to be surrounded by an area of rarefying osteitis. Treatment by means of polyantibiotic paste seems to have been effective in overcoming the periapical infection and in the later radiograph the apical seal appears to be complete.

3. In the third case calcification of the $\underline{2}|2$ has also been completely arrested as a result of the injury, and the pulp has subsequently become infected together with the adjoining bone.

In the present case root-canal treatment with polyantibiotic paste appears to have been successful, and radiographs following treatment show good regeneration of bone (*Figs.* 5 and 6).

Acknowledgements.—I should like to thank Mr. Betchley Boyd for referring *Case* 2 to me and Miss Whiteley of the Dental Photographic department for the photographs illustrating this communication.

Relation of the Nasal and Subnasal Components of Facial Height in Childhood

The relation between the components of facial height, nasal height, and subnasal height is investigated over the period from 4 years to 12 years of age. Longitudinal data are described and analysed. On the average the nasal component increases in relation to the subnasal. For individuals nasal height, as a percentage of subnasal height, may remain practically constant from age to age, or may increase. In a small group it was found that "bite-opening" procedures produced a temporary increase in subnasal height.—MEREDITH, H. V., KNOTT, VIRGINIA, and HIXON, E. H. (1958), *Amer. J. Orthodont.*, **44**, 285.

LETTERS TO THE EDITOR

January 8, 1959

Dear Sir,

I have read with great pleasure and profit Mr. Leech's paper on "A Clinical Analysis of Orofacial Morphology and Behaviour of 500 Patients attending an Upper Respiratory Research Clinic" in your December issue, but I must quarrel with both Mr. Leech and Mr. Ballard in their assessment of the role of digit-sucking in the aetiology of malocclusion. The swing of the pendulum of nature and nurture has in my opinion gone a little too far in the direction of attributing nearly all malocclusions to inherited or endogenous patterns. I can produce a very considerable number of cases where gross malocclusions have disappeared in a very short period of time in which no active treatment has been given beyond an appliance to discourage and break the habit of digit-sucking. I can also produce a considerable number of cases where my attempts to check the habit have failed and the malocclusion has persisted. I think it is utterly naïve and unrealistic to think that such cases would cure themselves by the development of a larger maxillary space if the habit was persisted in. It is, of course, true that this habit can be superimposed upon an unfavourable endogenous pattern, but I am quite sure that a considerable amount of malocclusion exists in which digit-sucking and digit-sucking alone is the aetiological factor. Its association with tongue-thrusting habits is brought about by the fact that the sucking creates an open bite and the tongue pushes into the space.

There is another factor in sucking habits which seems to have been overlooked, and that is the lip trap. I am inclined to think, and here is an opportunity for research by younger men, that many cases of protrusion in both Class I and Class II cases are initiated by an early sucking habit which causes some protrusion of the upper incisor teeth and some retrusion of the lower incisor teeth. This can happen quite early in the child's life, but once the lip has got into position behind the upper incisors it stays there, and a protrusion results. The cases of both divisions of Class II occurring in monozygotic twins which both Mr. Leech and I have reported, cases which many of us have seen with a division 1 morphology on one side of the mouth and a division 2 morphology on the other all suggest that the lip trap may well be a coincidental result of an early sucking habit.

Yours faithfully,

B. R. TOWNEND

Central Dental Clinic,
The Elms,
9 Bond Street,
Wakefield.

January 24, 1959

Dear Sir,

I was interested to read the letter by Mr. Townend concerning my paper printed in your December issue. His writings always command my greatest respect and I would appreciate the facilities of your journal for commenting on the points he raises.

One of our failings as orthodontists is that we so often assume one single cause for one particular effect. In the role of digit-sucking one school of thought will blame this habit for one particular type of malocclusion, whereas another will hold the tongue responsible. I was particularly careful not to commit myself in my paper when I said: "Which plays the dominant role, the thumb or the tongue, I leave you to judge". However, I do claim that the figures I produced put digit-sucking as an aetiological factor in its right perspective. That thumb-sucking can be the sole cause of malocclusion I am prepared to accept, but the incidence of this cause is infinitesimal compared with the large numbers of malocclusions encountered. My figures show that the only malocclusions where thumb-sucking can reasonably be blamed as the main aetiological factor were the anterior open bites and about one half of the increased incisor overjets on Skeletal I bases, i.e., less than about 3 per cent of all malocclusions.

Whilst many anterior open bites are associated with thumb-sucking there are also those where no such habit has occurred; these have a marked tongue thrust and interdental sigmatism. Where thumb-sucking is the suspected prime factor, cessation of this habit will often result in self-correction of the open bite (the child will give up the habit in his own time, irrespective of corrective appliances). Where the tongue behaviour is the principal cause the malocclusion will persist after the thumb-sucking has stopped and these cases are far less amenable to treatment. Where there is a thumb-sucking habit, a tongue thrust with interdental sigmatism, and a high Frankfort-mandibular plane angle the prognosis is hopeless. There are certainly more Class II, division 1 malocclusions present where thumb-sucking has never occurred than where it has.

To sum up, my paper does not prove which plays the dominant role, thumb-sucking or tongue behaviour. As I stated in my paper: "It is probable that they enhance one another". It does prove, however, that in some cases persistent thumb-sucking has no effect on the occlusion whatsoever.

With regard to Mr. Townend's last paragraph, where he states that the "lip-trap" as a cause of malocclusion has been overlooked, I would draw his attention to my paragraphs on "atypical swallowing" and "incompetent lips" where I have gone into this problem in great detail.

In conclusion, may I say how sorry I was that Mr. Townend was unable to be present when I gave this paper to the B.S.S.O. Jubilee Meeting. What a valuable discussion might have ensued. I only hope that this might be possible at a future meeting of the society.

Yours faithfully,

H. L. LEECH

The Watford and District Peace Memorial Hospital,
Watford,
Herts.

February 12, 1959

Dear Sir,

I was interested to read an article on removable orthodontic appliances, by Mr. J. Angelman, which appeared recently in THE DENTAL PRACTITIONER,

Whilst I am sure the author has derived clinical success with their use, it does seem to me that many of the principles of design have been ignored in their conception, and that their use in the hands of the unwary may lead to undesirable results.

I put forward the following observations:—

1. The use of incisors only as a support for the plate is surely creating a large and undesirable cantilever action on these teeth.

2. The use of the incisors as anchorage is quite insufficient for retraction of four premolars (as stated). With the consequent forward movement of the incisors the distally placed wire is hardly going to prevent $\frac{7|7}{|}$ from drifting mesially as it itself is moving forward with the plate.

3. The use of 1·0 mm. wire as a canine retractor has surely too vicious an action, even over a long range.

4. Patients should not have to check so many springs (re their position); children are invariably in a hurry and would overlook this point.

Economy in plates can sometimes be carried a little too far. Reference to C. P. Adams's book *The Design and Construction of Removable Orthodontic Appliances*, Chapter II, is suggested.

T. H. M. Wynne

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Liverpool, 3.

BOOK REVIEWS

ORAL SURGERY. By Kurt H. Thoma, D.M.D., Dr. Med. Dent. H.C. (Zürich), F.D.S. R.C.S. (Eng.); Professor of Oral Surgery, Emeritus, and Brackett Professor of Oral Pathology, Emeritus, Harvard University. Third edition. $10 \times 6\frac{1}{2}$ in. Pp. 1607+ xvi, with 1824 illustrations, 159 in colour. 1958. London: Henry Kimpton. £10.

The third edition of *Oral Surgery* by Kurt H. Thoma has been published in one volume comprising some sixteen hundred pages.

Considerable progress has been made in oral surgery since the book was first published in 1948, and every endeavour has been made to revive and to bring up to date the text with the new techniques now being practised.

Three completely new chapters have been added, including one on the radiographic examination of the face and jaw. This depicts the various techniques for taking extra-oral films with a dental X-ray machine, but the dental surgeon will find it difficult to take good quality diagnostic pictures with a machine of this type.

Though the principles of disimpaction, reduction and immobilization are accepted for fractures of the facial skeleton, the methods used to achieve immobilization are different from the accepted teaching of splinting and fixation techiques in common use in this country. Intra-oral trans-osseous wiring is not advised, lower border wiring through a submandibular incision being preferred. Fractures of the condyle are described in great detail; direct bone wiring of the displaced condyle through a pre-auricular incision is surprisingly still in use.

There can be few oral surgical procedures that have been omitted from this book, and not only is the accepted method described, but also the unusual technique has its place in the text. All the surgical techniques are beautifully illustrated in two-colour drawings, supplemented by first-class photography and X-ray reproductions. The case histories are rightly considered a necessary addition to the technical sequences and, since the last edition, many new cases have been added to illustrate further the text.

The third edition of Thoma's *Oral Surgery* is a very fine book. It is too detailed for general use by the undergraduate student, but must be considered an essential guide and book of reference for the postgraduate student and practising oral surgeon.

T. G. W.

HOLY TOOTH. By Edward Samson, F.D.S. R.C.S., F.C.S. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 133, with 24 illustrations as 13 plates. 1958. Bristol: John Wright. 16s.

Holy Tooth is not only the story of the history and associated ceremonies of the tooth of Buddha, but a philosophical and theological discussion on the attribution of miraculous powers to a religious relic. A religious relic as old as this famous tooth must obviously be steeped in mythology, and a large part of its history must have come down through the

ages by word of mouth. As to how far one can believe in any miraculous properties must be left to the faith of the individual. A scientific hypothesis may be formulated to account for some of these miracles, but Samson maintains that any scientific theory will never disprove the fact that a miracle is still a miracle. It must be remembered, however, before any attempt at explaining the miracle is made, that the veracity of the event must be proved first, unless one has supreme faith in the belief that what is said to have happened actually happened.

Whatever personal opinions we may have, this is an extremely interesting book and the philosophy expressed by Samson is worthy of further thought. All of it will be dismissed by the sceptic and much of it will not be believed by the average man, who does not possess the faith expounded by Mr. Samson. However, a profession which deals and treats with the human tooth will be made more aware of the symbolic meaning of the dentition by reading this treatise on the Holy Tooth. They will undoubtedly give more respect to this part of the human anatomy in the realization that since the dawn of man the teeth have always been held in an aura of mystery and, indeed, still maintain a mystery of their own peculiar disease.

N. L. W.

COMPLETE DENTURE PROSTHESIS. By DANIEL H. GEHL, D.D.S., Professor of Denture Prosthesis, Marquette University School of Dentistry, Milwaukee, and O. M. DRESDEN, D.D.S., Dean, Marquette University School of Dentistry, Milwaukee. Fourth edition. $9\frac{1}{4} \times 6$ in. Pp. 542+viii, with 310 illustrations. 1958. Philadelphia and London: W. B. Saunders Co. 77s.

THE first two editions of this book were written by Dr. R. C. Schlosser, who was for many years the well-known Professor of Dental Prosthetics in Northwestern University, Chicago. The third edition was compiled under the caretaker authorship of Schlosser and Gehl. The fourth edition, with another change of authorship, comes from Marquette University, Milwaukee.

The original nature of the book is preserved in the latest edition. It is essentially a book concerned with techniques used in the construction of complete dentures, both clinical and laboratory phases being treated. It must be said that the descriptions of these techniques are thorough and clear; they are also illustrated with good and well-selected photographs and line drawings. Always alternative methods are described and a good deal has been done to bring the text into line with the newer materials available in full denture prosthetics. To some this may be all that is required of a book on complete dentures.

The reviewer would suggest, however, that dental prosthetics is so largely dependent on a knowledge of applied anatomy and physiology that in a book of this size considerable space should have been devoted to the discussion of biological principles. Whereas some little space in the book is devoted to the stereotyped anatomy of the text on this subject, it is suggested that such knowledge should have been presumed. There is little tie-up between this and the descriptions of the clinical sequences which follow. Rather should the anatomy have been concerned with the changes in muscle, bone, and mucosa seen in the edentulous state and in age atrophy. More especially a full discussion of neuromuscular physiology and its significance to dental occlusion is lamentably absent. Occlusion is rather treated from the old mechanistic viewpoint, which is now proving inadequate.

This book, then, can be commended for its clear descriptions of techniques. Since diagnosis, treatment planning and prognosis are based on biological issues receiving scanty attention, these important aspects seem to have received insufficient consideration.

G. A. L.

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Students are reminded that they may become subscribers to the DENTAL PRACTITIONER at half the normal subscription (£1 1s.) provided their order is signed by the Dean of their Faculty.

LOCAL APPLICATIONS OF THE "WATKIN" APPLIANCE

By **HAROLD G. WATKIN**, F.D.S., D.Orth. R.C.S. (Eng.), **PHYLLIS A. WATKIN**, D.Orth. R.C.S. (Eng.), **E. J. S. CLIFFORD**, L.D.S. (V.U. Manc.), and **JUNE P. MURRAY**, B.D.S. (L'pool)

THE chief object of this demonstration is to show the ease with which perfect control of the movement of teeth is obtained. Loops are formed along a wire with a pair of loop-forming "Watkin" pliers (*see Fig.* 6). These loops fit accurately into McKeag tubes welded to tooth bands. The adjustment of the loops can produce tooth movements in all directions, including root movement.

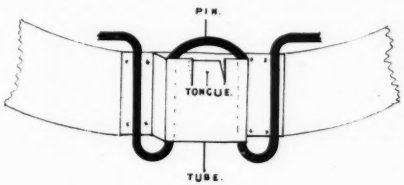


Fig. 1.

The front surface of the tubes have saw cuts in them (*Fig.* 1) which form a tongue, and when this tongue is pressed in (after the loops have been inserted) it forms a perfect lock. To unlatch the lock it is only necessary to pass the end of a small, flat plastic up the

Fig. 2.

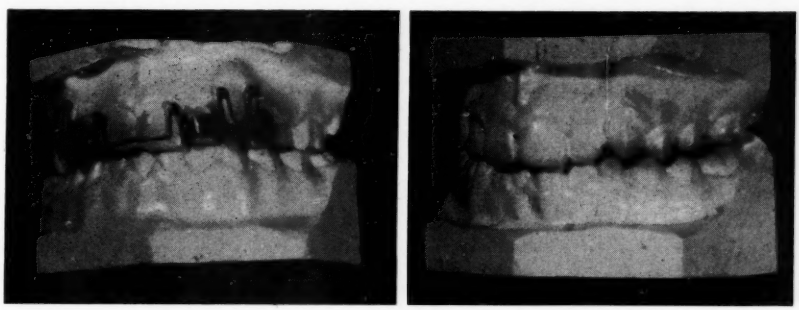


Fig. 3.

A demonstration given at the Jubilee Meeting held on May 10, 1958.

tube. This bends the "tongue" back to its original position and the loop is freed.

2|2 are too close together to allow 1|1 to be moved lingually. The appliance is activated by adjusting the loops the width of a vertical tube beyond the passive position with the horizontal wire pressing 1|1 lingually when necessary. (*Fig.* 2.)

A case of Class II, division 1 with 3|3 outside the arch and 6|6 carious: extract 6|6 and move 54|45 into normal relationship with the wire pressing 3|3 into the arch. (*Fig.* 3.)

A case where 1|1 have been lost and it is desired to move 2|2, with parallel root

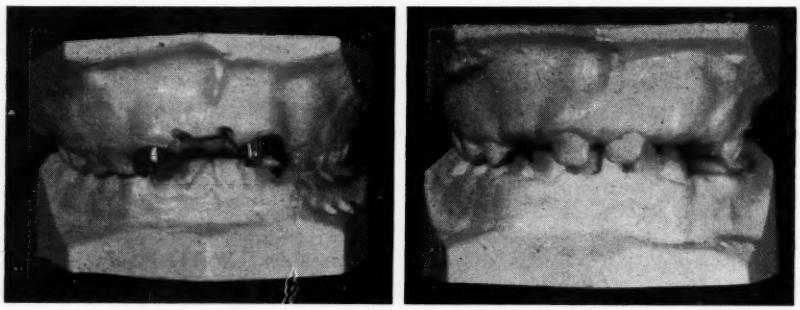


Fig. 4.

Fig. 5.

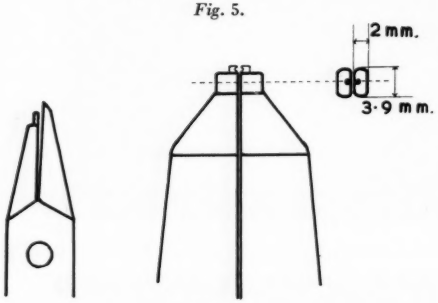


Fig. 6.

movement, close together to be crowned to replace the lost 1|1 is shown in *Fig.* 4.

The loops are formed with special loop-forming "Watkin" pliers, illustrated in use in *Fig.* 5, and the grooved tips at the ends (*Fig.* 6) are used to complete the paralleling of the sides of the loops as shown by the broken lines in *Fig.* 5.

Materials and Equipment

Wire

0·35 mm. S.S. Hard.

Band Material

Incisor	3·0×0·1 mm. S.S.
Premolar	5·0×0·15 mm. S.S.
Molar	5·0×0·15 mm. S.S.

Instruments

Spot-welder
Band-pinching pliers (Visick)
Contouring pliers
Loop-forming "Watkin" pliers
Coil-forming pliers
Band-pusher
Flat plastic instrument.

A PIN VICE TO USE IN MAKING COIL SPRINGS

By **H. E. WILSON**, L.D.S., D.D.O., D.Orth.

A No. 121 Pin Vice, 3 in. long, purchased in an ironmonger's store, was adapted to fit the dental straight hand-piece by removing the hollow shank and replacing it with a solid one 2·3 mm. in diameter. A small loop was soldered near the beaks. (*Fig.* 1.) The range of the beaks, 0·0–2·0 mm., is much greater than that usually required for core wires for orthodontic coil springs.

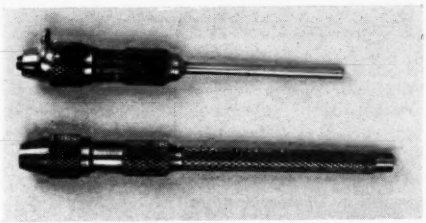


Fig. 1.—The original pin vice (*bottom*) with the modified one above.

The core wire on which the spring is to be wound is tightened in the beaks. The spring wire is threaded through the "jig" (Beresford, 1947; Adams, 1957), and tied to the loop on the vice. (*Fig.* 2.) The spring is made in the usual way with the straight hand-piece.

With this pin vice it is unnecessary to make and store core wire with attached mandrels for all diameters of coil springs.

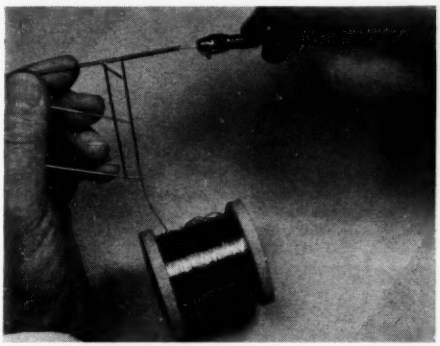


Fig. 2.—Shows the pin vice in use with the Beresford type jig.

REFERENCES

ADAMS, C. P. (1957), *The Design and Construction of Removable Orthodontic Appliances*, 2nd ed., 110. Bristol: Wright.

BERESFORD, J. S. (1947), *Trans. Brit. Soc. Orthodont.*, 97.

A SIMPLE SPRING TO ROTATE AN INCISOR

By **H. E. WILSON**, L.D.S., D.D.O., D.Orth.

THE rotation of a single incisor is at times a difficult technical problem in relation to the amount of tooth movement required. The usual methods, such as the couplet with the labial and lingual spring, or T-spring in removable appliances, or fixed multiband techniques, are not always suitable because of the position, degree of rotation, or stage in eruption of the tooth (*Fig.* 1).

The spring to be described is one which may be used instead of other methods, or at times where other techniques are not successful. It is simple, easily made, easily adapted, easily fitted, can be made of stainless steel wire up to 0·7 mm. diameter, and is therefore strong enough to be self-supporting. It consists of a simple cantilever spring (*Figs.* 2, 3), with coil (A) designed to move the tooth labially. At the point of contact there is a second coil (B), but in the reverse direction. This latter coil makes a point contact with the tooth at the part to be moved labially and it also activates the

Demonstrations given at the Jubilee Meeting held on May 10, 1958.

labial extension. The wire is continued from the second coil (B) to the labial aspect, where it makes contact with the tooth as far as possible from the coil (B). It ends in a small

Fig. 1.—Shows the spring on $\underline{1}^{1}$, which, following exposure, had erupted about one-third of the crown labially and rotated. Rotation of these teeth by any other techniques would have been more difficult.

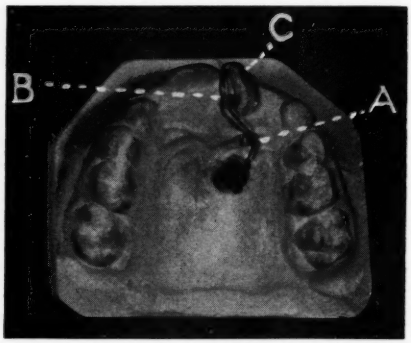


Fig. 2.—Shows the spring designed to move the tooth in the arch but rotated almost 90°. Any other technique would produce the same result but not so easily.

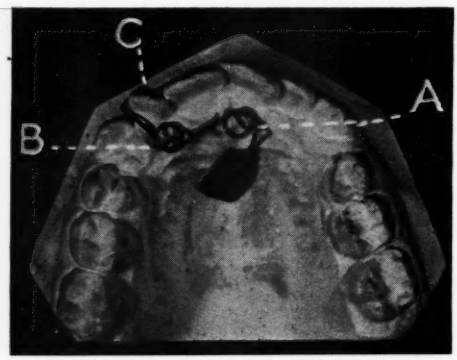


Fig. 3.—Shows the spring used on a right upper lateral rotated in a few months and which could just as easily have been achieved by any other techniques.

loop to prevent damage to the tooth and to make a surface contact, so reducing the possibility of displacement.

If the loop (A) is opened the spring will be activated and the tooth moved labially. If the loop (B) only is opened the extension will be activated and the tooth at (C) will move palatally while it will be retained at (B), thus rotating the tooth at or near (B). If both loops (A) and (B) are opened the tooth at (B) will move labially and at (C) palatally, thus rotating the tooth somewhere between these two points. The degree of rotation and displacement decides the comparative activity between the two coils. The points of contact should be on the same horizontal plane, otherwise tilting of the tooth occurs.

Hypersensitivity to Procaine

The removal of several molar teeth, anæsthetized with procaine, from a female aged 56, caused her to develop a rash on her cheek, neck area, and exposed part of the chest. The swelling and the throbbing pain had robbed her of sleep and she reported that recent extractions of anterior teeth had produced similar results.

Scratch tests for sensitivity to 2 per cent procaine and 2 per cent xylocaine were carried out. There was no immediate reaction, but after 24 hours, in the case of procaine, swelling, inflammation, etc., occurred. Contact with the unbroken skin with procaine produced a reaction; drips of anæsthetic from the syringe having fallen on the napkin soaked through and produced the rash on the chest.

For subsequent extractions, xylocaine was used without any untoward effect.

Allergic reactions to procaine are so rare as to render routine tests unwarranted; if doubt exists, a scratch test should be carried out.—SULLIVAN, H. R. (1958), *Aust. dent. J.*, **3**, 187.

A LONGITUDINAL STUDY OF THE RESULTS OF PREMATURE EXTRACTION OF DECIDUOUS TEETH BETWEEN 3–4 AND 13–14 YEARS OF AGE

By **LILAH M. CLINCH**, M.A., F.D.S., D.Orth. R.C.S.
Statistical Appendix by **M. J. R. HEALY**, B.A.
Rothamsted Experimental Station

INTRODUCTION

THERE are many references in dental literature to early loss of deciduous teeth and the resultant space loss—in fact few subjects have aroused so much comment. From Fauchard, in 1742, we can find mention of the inevitability and, at the same time, the undesirability of removing these teeth before they would be shed naturally. Recently, some writers have raised doubts as to the damage to the permanent dental arches which is likely to occur. Seipel (1947, 1948), Lundström (1955 a, b), Breakspear (1951), Friel (1948, 1953), and others have shown that a lack of space at a later stage does not always follow these extractions, and yet we all see, probably daily, spaces much reduced or even closed following premature extractions. But then orthodontists see, on the whole, malformed mouths in which space loss would probably be greater and do more damage than in well-formed mouths.

Most of the work published on this subject has shown the results of premature loss without any history of the occlusion before the extractions, or of the changes which took place during the years intervening between the extractions and the final result. It is misleading to attribute imbrication in the permanent dentition to premature loss of deciduous teeth when there may always have been imbrication, but that type of mistake is likely to happen if conclusions are drawn only from the history of the extractions. From serial models it is possible to tell the type of occlusion before the extractions, the stage of development as distinct from the chronological age at which the teeth were removed, and the changes which followed. This paper is an attempt to summarize this information from 29 children who had deciduous teeth extracted owing to caries and before their natural shedding time, and whose occlusion had been studied during 11 years.

MATERIAL

The material for this study is from a series of models of children of whom impressions were taken at yearly intervals between 3 to 4 and 13 to 14 years of age, that is, each series of models covers 11 years. They are an unselected group of children who happened to be born at the same maternity hospital, and whose mothers attended ante- and postnatal clinics in health centres in the same neighbourhood.

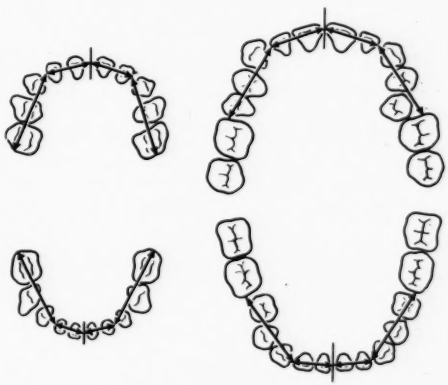


Fig. 1.—Arch measurements.

Details of the Series.—

1. The original number of series: 106 children.

2. The number of series at the final observation: 59.

Given at the meeting held on October 13, 1958.

3. Loss of numbers during the investigation:

a. Age when cases were lost:—

3–4 years: 7 cases
4–5 years: 12 cases
5–6 years: 9 cases
6–7 years: 5 cases
7–8 years: 4 cases
8–9 years: 3 cases
9–10 years: 4 cases
10–11 years: 2 cases
12–13 years: 1 case
Total: 47

b. Reasons for loss:—

Refused (mostly when starting school and no longer attending the postnatal clinics): 20 cases.

Moved and address unknown: 17 cases.

Illness: 7 cases.

Orthodontic treatment: 4 cases.

4. Occlusion of final series:—

Good occlusion: 31.

Normal arch relationship with subnormal arches: 15.

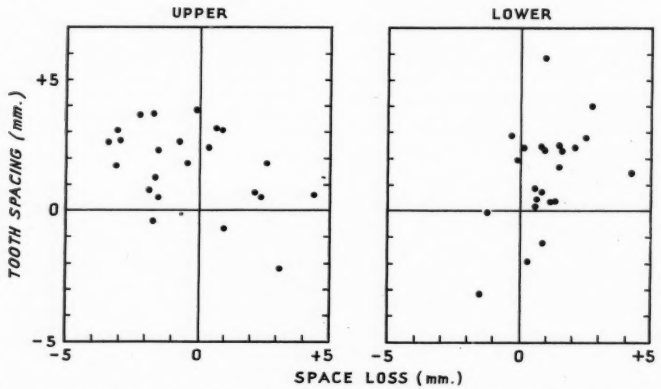


Fig. 2.—Association between total space loss and initial crowding in all the extraction cases.

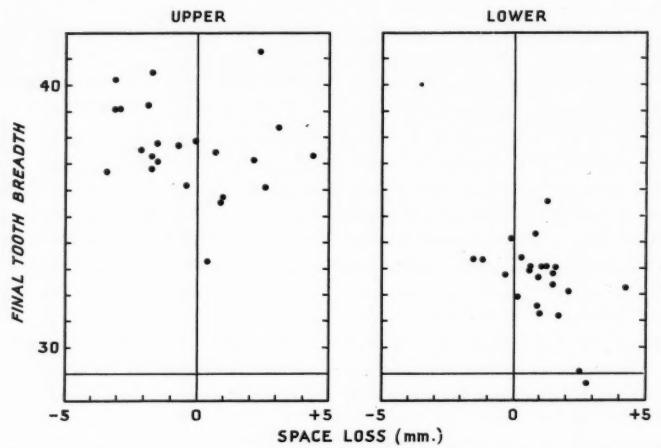


Fig. 3.—Association between total space loss and the total breadths of the 5 permanent teeth in all the extraction cases.

Postnormal occlusion of mandibular arch: 11 (including 5 with subnormal arches).

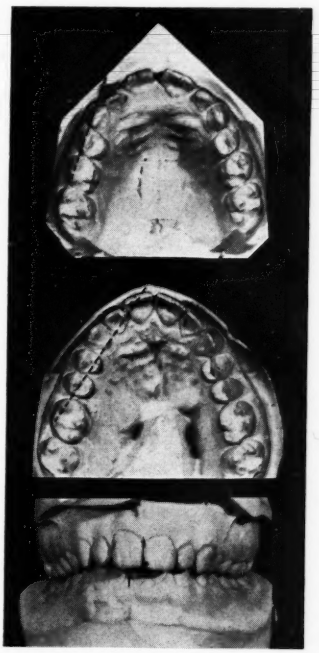
Prenormal occlusion of mandibular arch: 2 (both with subnormal upper arches).

Only two of the final series are anxious for orthodontic treatment. This fact, and the details concerning the reasons for the loss in numbers, are given to show that the final series remain a fair cross-section of unselected children, and does not consist of children whose parents have observed a malocclusion and have returned hoping to have it treated.

In 29 of the 59 full series, teeth have been extracted prematurely, and it is with these that this paper is concerned, apart from 11 random non-extraction cases which have been used as controls.

METHOD

Two measurements were taken of the quadrants of each upper and each lower model (*Fig.* 1):—



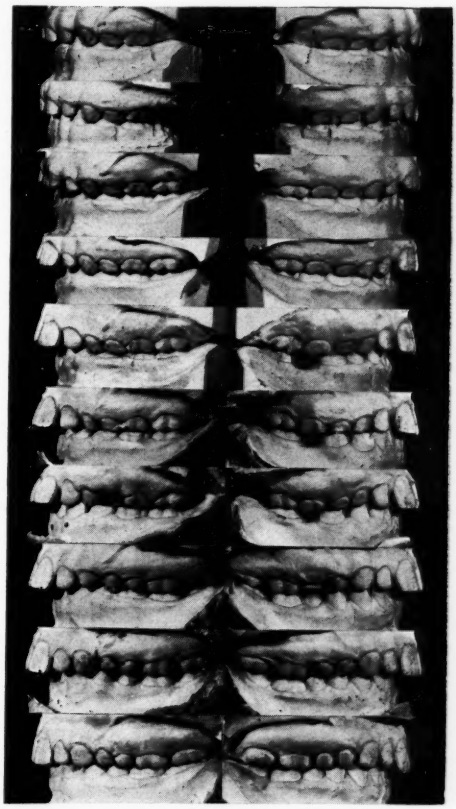
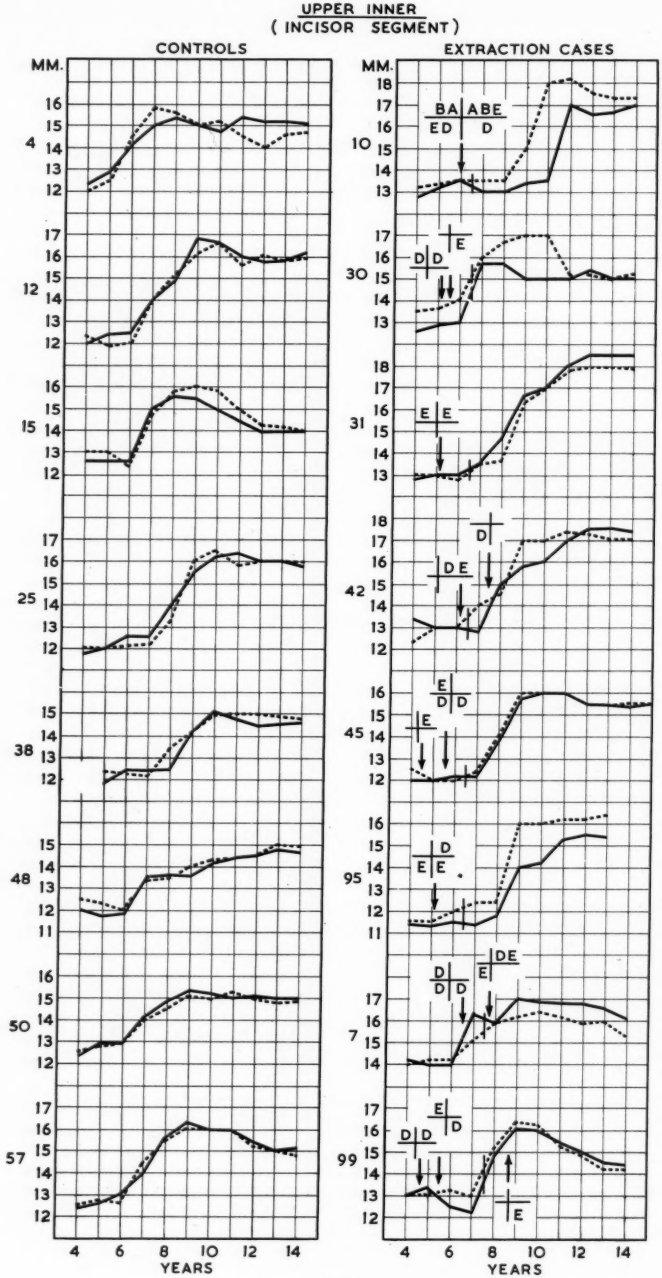


Fig. 4.—Serial models. Unilateral postnormal occlusion. The lower right E was extracted at 7 years 6 months. The space for the second premolar was reduced chiefly by the drifting or tilting forward of lower first permanent molar into good anatomical occlusion with the upper. The forward movement anterior to the extraction continued to some extent, as can be seen by the positions of the upper E and lower D. As the lower second premolar erupted it moved the permanent molar distally and forced the opposing upper molar to rotate around its mediolingual cusp, which was in the central fossa of the lower tooth. The occlusal views show the position of the upper molar before the extraction of the lower tooth and its rotation at 14 years. The front view of the models shows that, despite the continuing forward movement of the lower teeth, the right side did not move as far as the left and the centre line in the lower has shifted towards the site of the extraction.

On the left side the early tendency to postnormality of the lower arch corrected itself.


UPPER INNER
(INCISOR SEGMENT)
CONTROLS
EXTRACTION CASES
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YEARS
4 6 8 10 12 14

Fig. 5.

1. From the midline to the distal contact point of the lateral incisor or, if the lateral incisor was shed or not in the line of the arch, to the mesial contact point of the canine. (The midline on the lower model was taken as the midpoint between the central incisors. In most cases the elongation of the median raphé was used as the upper midline; if this was not possible the midpoint between the centrals was used.)

2. From the distal point used in the last measurement to the distal surface of the second deciduous molar as near to the contact point with the first permanent molar when it erupted as could be judged, or to the mesial contact point of the first permanent molar if the second deciduous molar had been extracted or shed.

No quadrants were included in which permanent teeth had been extracted, but this only applied to two quadrants.

In addition to the arch measurements, the tooth-breadths of the first and last models were also measured, as the problem of the variation in final loss of space might be connected with a primary tendency to crowding due to a discrepancy between tooth size and arch size (as shown by Lundström), apart from the result of the extraction. This was studied in two ways:—

1. A determination of the association between (*a*) relative spacing in the deciduous dentition before any extractions had occurred and (*b*) the amount of space loss during the whole observation period.

2. A determination of the association between (*a*) the size of the permanent teeth and (*b*) the amount of space loss just mentioned.

This problem must, of course, be studied on all the material later, but it was interesting to see if the correlation between space loss and extractions was stronger than the correlation between space loss and tooth size in the extraction cases.

Fig. 5.—Graphs of the incisor segments of the upper arches of the controls and of cases with extraction of deciduous teeth before the eruption of the first permanent molars. The age of the eruption of the first permanent molars is indicated by a small vertical bar on each graph of the extraction cases. The teeth extracted and the ages when the extractions occurred are indicated by arrows. Right side—continuous line. Left side—dotted line. This measurement tends to increase in the extraction cases due to tilting distally of crowns as roots move forward with bone.

Two control cases are of interest:—

Case 12: There is a *large* increase in the incisor segments. This child sucked 3 fingers all through the period under investigation.

Case 25: There is a *large* increase in the incisor segments. At 4 years there was rotation of upper deciduous lateral incisors and very little spacing. Despite large teeth there is no imbrication of the incisors at 14 years. An exception to the general rule.

The statistical analysis of these measurements is appended. Dealing with the clinical examination of each series of models, notes were made on the following points:—

1. The occlusion of the first models at 3–4 years of age, with special reference to spacing in the arches and the alinement of the teeth at 13–14 years.

2. The tooth or teeth extracted.

3. The time of the extraction, chronological age, and stage of the dentition and the age at which the first permanent molars erupted.

4. Unilateral or bilateral extractions and any alteration in the midline.

5. The effect of cuspal interlock if the extractions were in opposing quadrants of the arches or in one quadrant only.

6. The relative amount of space loss in upper and lower arches and whether the reduction was due to a mesial drift of the teeth

distal to the break in the arch or a lack of forward growth mesial to the break in the arch.

7. The occlusion of the final models, with special reference to areas of imbrication (if present), incisor, canine, or premolar, and the order of eruption of the teeth.

These notes were then co-ordinated with the statistical findings:—

1. Spacing in the deciduous dentition seems

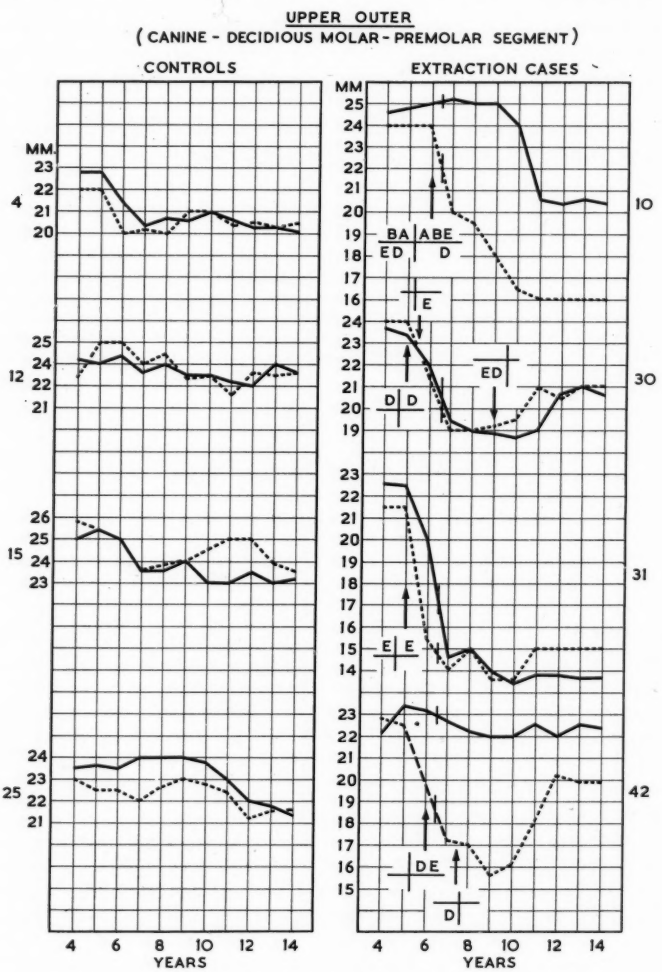

Fig. 6.—Graphs of canine deciduous molar or premolar segments of the upper arches of the control and early extraction cases. Details as before.

Two control cases are of interest:—

Case 12: Shows a slight *increase* on the left side in this segment. There is a space of 1 mm. between the lateral incisor and canine at 14 years (this is the finger-sucker whose incisor segment was also abnormally large).

Case 57: There is large decrease on the right side in the outer segment (similar to the effect of extraction). Here the 6 impacted on E and knocked it out. At 14 years the space for $\underline{5|}$ is closed.

to have a connexion with the degree of space loss after extractions, but the connexion differs in the two arches. It is very apparent in the upper arch and less so in the lower. is less surplus space after the shedding of the deciduous molars in the upper than in the lower. This explains to some extent the findings in the measurements of the extraction

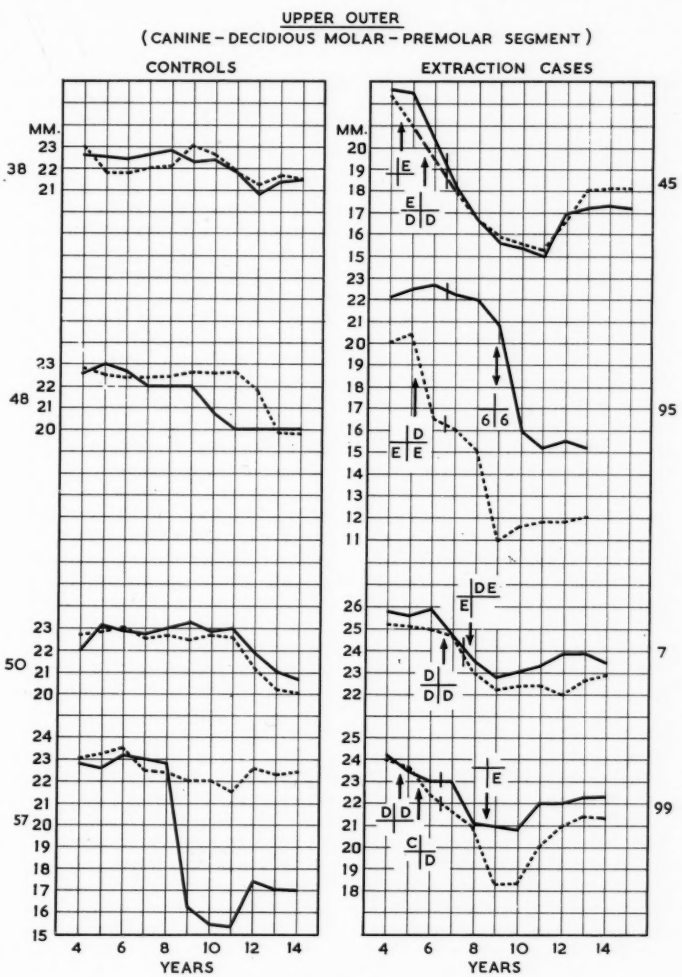

Fig. 6 (continued).

There are two factors which must be borne in mind when comparing the behaviour of the upper with the lower arch. First, the space loss after extraction is always greater in the upper than in the lower, and secondly, there cases that there is a significant correlation between space loss (the decrease from the first to the last models) and spacing (the difference between arch measurement and total tooth measurement in the first models), but it is a

negative correlation in the upper and a positive in the lower (*Fig.* 2). The difference in the two arches needs more elucidation and it is hoped that it may be possible to explain it more clearly after the correlations in the non-extraction cases have been worked out.

This also applies to tooth size and space loss, as a significant correlation was found between the total breadth of the 5 lower permanent teeth in each quadrant and the space loss, and in the upper this correlation was not significant (*Fig.* 3).

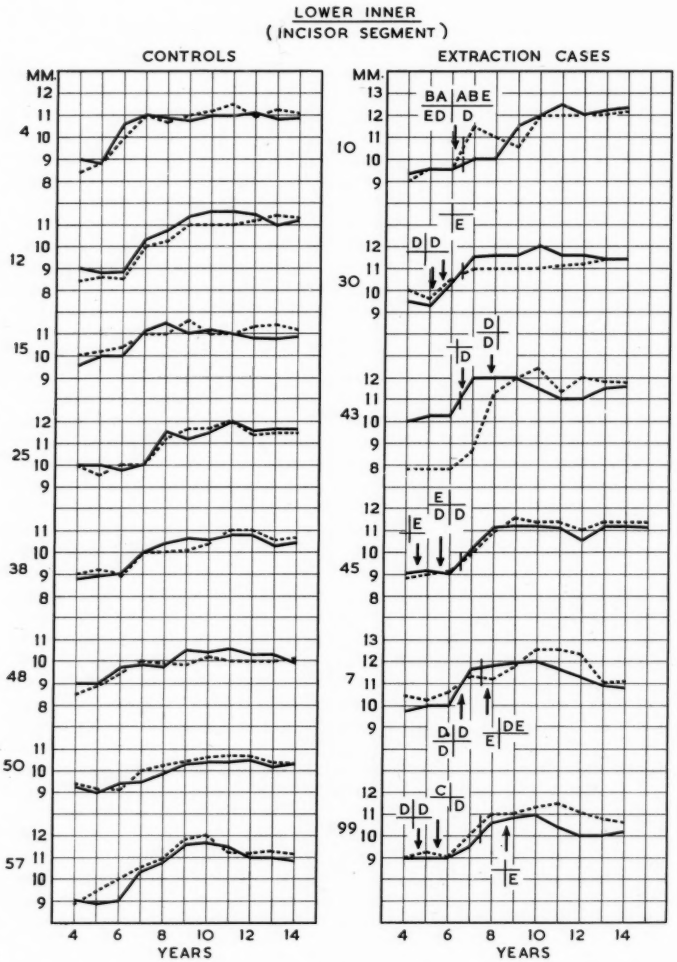

Fig. 7.—Graphs of the incisor segments of the lower arches of the controls and early extraction cases. Details as before. As in the uppers this measurement tends to increase in the extraction cases but to a lesser extent.

In children with well-developed arches the migration was usually small and temporary, and in one case there was not even a temporary reduction in space. Of the 29 cases, 10 showed

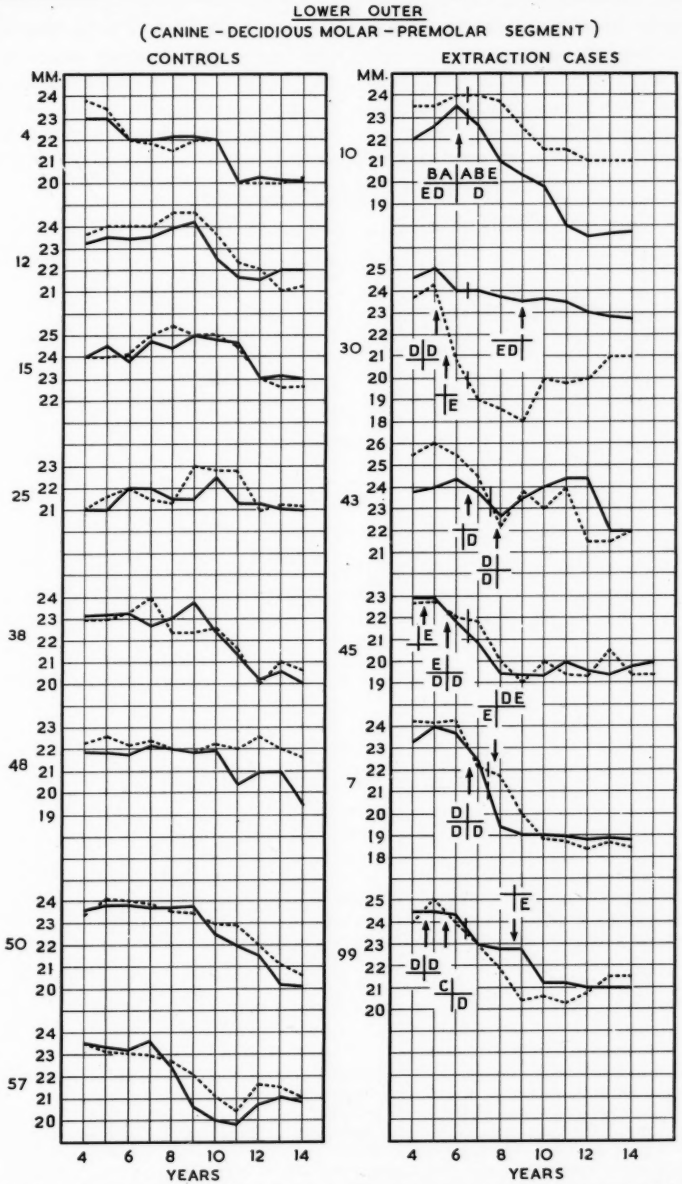

Fig. 8.—Graphs of the canine deciduous molar or premolar segments of the lower arches of the controls and early extraction cases. Details as before. Space loss less than in the upper.

Note on one control case:—

Case 25: There is no decrease in the outer segment. At 4 years the lower canines were buccal to the line of the arch and measurement from B to E was therefore less than the tooth breadths of CDE on each side.

As in the upper arch there has been an unusual degree of jaw growth, and at 14 there is good alinement of the canines and premolars.

no imbrication in the final models (some had spacing) after the full eruption of the premolars and second molars, despite the extraction of both first and second deciduous molars in all quadrants of both arches between $6\frac{1}{2}$ and $8\frac{1}{2}$ years; all these cases had good spacing in the first models. On the other hand the greatest permanent damage was done in the less well-developed arches in which there was no spacing at 3–4 years. The lack of space tended to increase in subnormal arches.

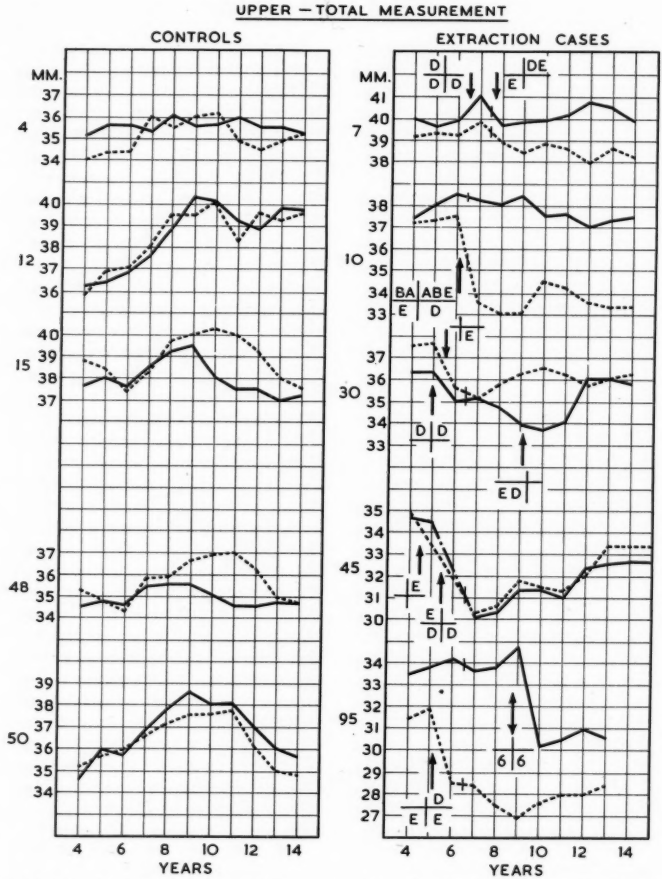

Fig. 9.—Graphs of total measurements of upper arch quadrants of controls and early extraction cases. Areas of imbrication in upper arches in extraction cases at 14 years:—

Case 7: Upper left incisor and canine spaces reduced.

Case 10: Upper left second premolar in palate and space nearly closed. Right canine space reduced.

Case 30: Upper right canine space reduced and left canine space slightly reduced.

Case 45: Upper canine and first premolar spaces reduced on both sides.

Case 95: Prenormal mandible. Upper canine spaces closed and incisors imbricated.

Case 31: Prenormal mandible. Upper second premolar spaces reduced.

Case 42: Upper left canine space reduced. On the right the combined measurement of upper CDE was slightly less than that of 345. Although there was no extraction in the lower arch there was marked imbrication of the incisors at 14 years.

Case 99: Upper premolar space reduced.

2. The extraction of the second deciduous molar produced considerably more space loss than the extraction of the first deciduous molar. Only one case had incisors extracted and this showed no permanent space loss.

mandible. The other had a lower first deciduous molar extracted at 5½ years; this case had good spacing at 4 years and at 14 years there was spacing between the upper canines and first premolars on both sides and in the lower

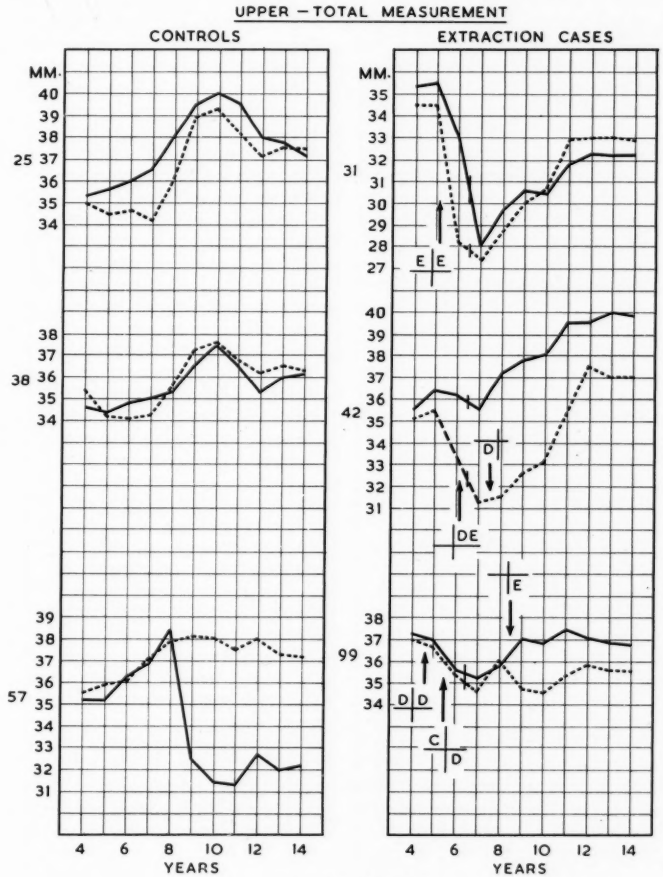

Fig. 9 (continued).

3. If there were extractions either of first or second deciduous molars before the eruption of the first permanent molars, the loss of space was never fully recovered in the upper arch. In the lower, 2 out of 7 arches showed no imbrication even after very early extractions, but 1 of these was a case of prenormal

on the non-extraction side. On the extraction side although there was no imbrication there was no spacing; so it would appear that there was a loss of space. The permanent space loss after extractions before the eruption of the first permanent molars in this material is contrary to Seipel's findings of no loss of

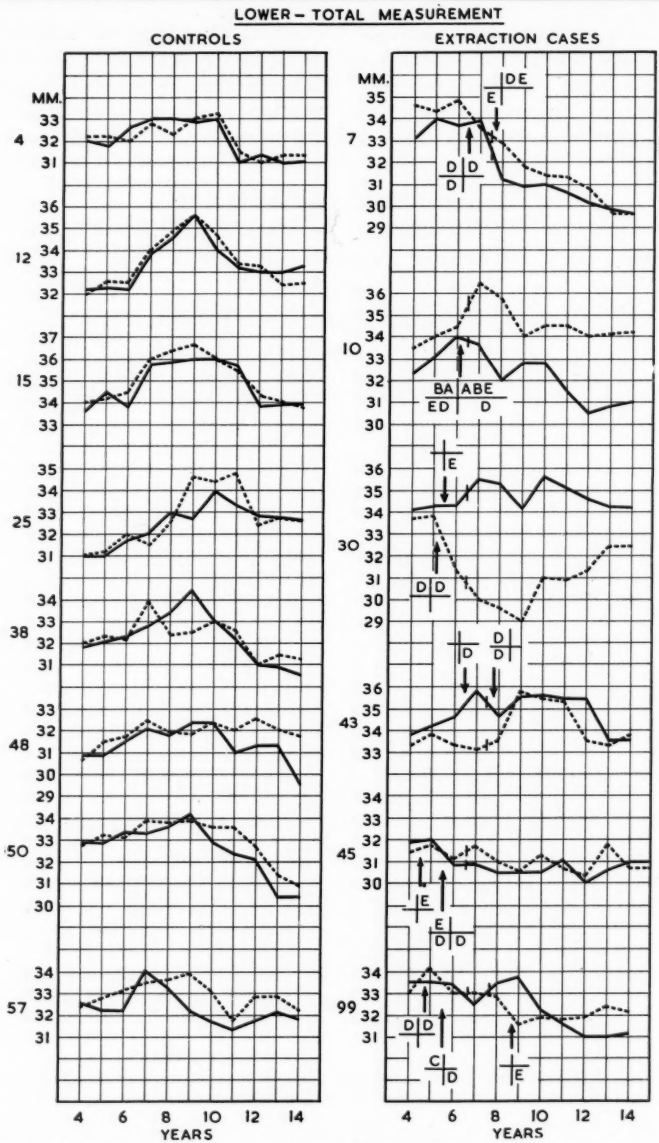

Fig. 10.—Graphs of total measurements of lower arch quadrants of controls and early extraction cases. Areas of imbrication in lower arches in extraction cases at 14 years:—

Case 7: Lower left canine and first premolar, and right second premolar spaces reduced.

Case 10: Lower left canine and lateral incisor space reduced.

Case 30: Lower left canine and lateral incisor space reduced.

Case 43: No imbrication but there is spacing at 14 years in all quadrants except the lower left where D was extracted 12 months before the eruption of the first permanent molar.

Case 45: Imbrication of lower incisors.

Case 99: Lower right first premolar space reduced, and left second premolar space reduced. Also imbrication of incisors.

space in 25 per cent of 50 children examined who had deciduous molars extracted at 3–5 years. He compared the right and left sides in cases of unilateral extractions.

The result of extractions at later stages of arch development were so varied that no generalizations could be made.

this it would seem that a comparison between space loss in the lower arch on the right and left side in unilateral extraction cases may not be very accurate and could be misleading.

5. Cuspal interlock seemed to reduce the space loss in some cases and not in others. One case of postnormal mandibular arch

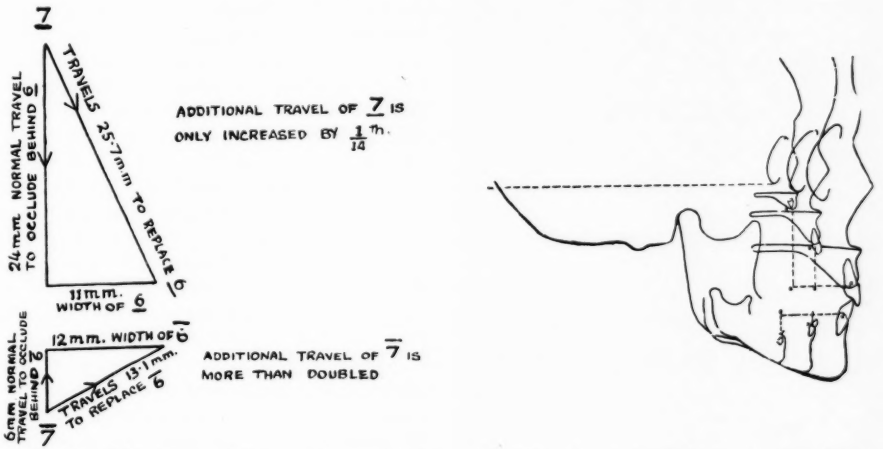
7
TRAVELS 25·7 m.m TO REPLACE 6
24 m.m. NORMAL TRAVEL TO OCCLUDE BEHIND 6
11 m.m. WIDTH OF 6
ADDITIONAL TRAVEL OF 7 IS ONLY INCREASED BY 1/14th.
12 m.m. WIDTH OF 6
6 m.m. NORMAL TRAVEL TO OCCLUDE BEHIND 6
TRAVELS 13·1 m.m. TO REPLACE 6
ADDITIONAL TRAVEL OF 7 IS MORE THAN DOUBLED

Fig. 11.—Friel. Increased distance of movement in upper arch less than in lower after extraction of first permanent molars.

4. Unilateral extractions had varying effects. Twelve of my series had unilateral extractions in either the upper or lower arch. In these, 7 showed no alteration in the midline. One showed a temporary shift towards the site of the extraction of the upper midline as compared to the lower after the extraction of an upper first deciduous molar, but the midline was correct at 14 years. Two showed a temporary shift of the lower midline as compared to the upper after the extraction (of a lower first decidous molar in 1 case and lower first and second deciduous molars in the other), but again the midline was correct at 14 years. Two showed a permanent shift of the lower midline within a year of the extractions; of these 1 had a lower second deciduous molar extracted and the shift was 3·8 mm. towards the site of the extraction at 14 years; the other lost a lower first deciduous molar, and the shift was 3·5 mm. at 14 years. From relationship, in which a lower second deciduous molar was extracted, showed the mediolingual rotation of the upper first permanent molar occurring as the lower first permanent molar which had drifted mesially was moved back by the eruption of the second premolar (*Fig.* 4). It demonstrates how a molar can rotate at a late stage in an unbroken arch. This case showed, too, the permanent shift of the lower midline, the space for the premolar being obtained by the forcing or tilting distally of the molar and the lack of forward movement anterior to the extraction was not corrected.

The effect of extractions in opposing quadrants, apart from the occlusal cusp relations, is difficult to assess. In one case the distal surface of the slightly overerupted upper second deciduous molar seemed to be keeping the lower first permanent molar from moving mesially after the loss of the lower deciduous

molars, as the extractions were done soon after the eruption of the first permanent molars and yet there was no reduction in space in this quadrant: in the same case in the upper arch after the loss of second deciduous molar the second premolar space closed completely. In another case the lower first deciduous molar seemed to prevent the mesial shift of the upper second deciduous and first permanent molars on one side but not on the other.

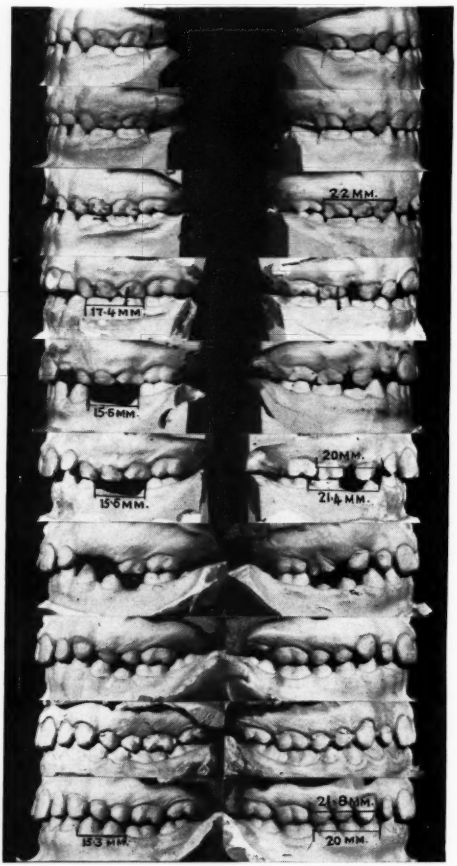

Fig. 12.—Serial models. The upper right first deciduous molar extracted at 6 years 3 months. At 6 years EDC| measured 22·0 mm.; at 9 years 6–2| measured 20·0 mm.; at 14 years 543| measured 21·8 mm.

The lower right first deciduous molar extracted at 8 years 6 months, but a reduction in space is possible as 543| measure 20 mm.

The lower left first and second deciduous molars extracted at 7 years 6 months. The premolar space is reduced 2 mm. in the first year after the extraction and then changes little; further reduction is possible as the premolars measure 15·3 mm. in the final models and this enables the second molars to occlude correctly.

6. The relative amount of space loss in the upper and lower arches can be seen more clearly in the graphs made from the arch measurements. (*Figs.* 5–10.) It is obvious that the reduction in space, both temporary and permanent, is much greater in the upper than in the lower. In the upper arch more space appears to be lost by the mesial migration of the teeth posterior to the site of the extraction, while in the lower there appears to be a greater tendency to space loss due to lack of forward growth of the teeth anterior to the extraction. The greater tendency to shift of the lower midline in unilateral extraction cases would demonstrate this. Friel (*Fig.* 11) has shown the reason why mesial migration of the second permanent molar after the loss of the first permanent molar is so much greater in the upper than in the lower. By superimposing the mandible at birth on the adult mandible, with the anterior border of its ramus in the vertical plane of the corresponding adult surface and with its lower border alined on the lower border of the adult mandible, he demonstrated that, although the forward growth of the upper and lower jaws is almost the same, the vertical growth is much greater in the upper jaw than in the lower. Hence only a slight change in the angle of descent and a slight increase in the distance of movement (an addition of 1/14) is necessary to enable the upper second molar to move into the first molar space; in the lower, however, the second molar has to make a much greater angle and hence a much greater increase in the distance of movement (which is more than doubled) to replace the first molar. In the same way, if the second deciduous molar is extracted before the eruption of the first permanent molar in the upper arch, the first permanent molar may erupt in contact with the first deciduous molar by only a slight additional movement, whereas in the lower arch the additional movement of the first

permanent molar would be so much greater that there is never such a marked loss of space.

7. The order of eruption of the teeth had some effect on determining the area of imbrication. Naturally, where there was a reduction region, due to the lesser dimensions of the permanent teeth. But it should be remembered that if the second permanent molars are to occlude correctly, this extra space in the premolar region should be used up partly to accommodate the permanent canine and

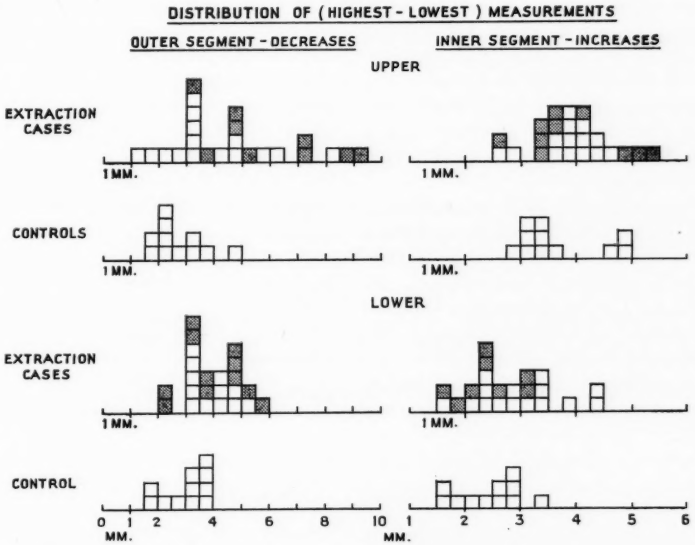

Fig. 13.—Shows the distribution of (highest — lowest) measurements for the four segments in all the extraction cases and in controls. In the control cases the right and left sides are averaged. In the extraction cases the right and left sides are averaged only when the extractions are bilateral. The anomalous value in control *Case* 57 is omitted. Each square is one case. The shaded squares are the cases with extractions before the eruption of the first permanent molars. This demonstrates the greatest degree of either space decrease or increase in each case—some of the decrease and increase may be only temporary in the extraction cases.

in space the canine was usually crowded out of the arch if it erupted after the premolars, but if the upper second deciduous molar was extracted before the eruption of the first permanent molar the space for the second premolar was invariably reduced rather than the canine space. The eruption of the second molars before the premolars did seem to have some effect on the space loss, but it happened rarely. In only 13 out of 116 quadrants the second molar preceded the premolars and in 10 of these (6 lower and 4 upper) there was a reduction in premolar space. It has been stated that there is a certain tolerance for decrease of space values in the premolar partly to allow a greater mesial migration of the lower first permanent molar than the upper (*Fig.* 12). Friel shows this clearly as a stage in the development of occlusion, and if this alteration in the molar relationship is prevented by premolars erupting into a reduced space, then the occlusion of the teeth distal to the space loss will be incorrect.

To summarize the impressions made by this study of these models, only two definite conclusions were reached: first, that extractions before the eruption of the first permanent molars resulted in permanent loss of space but to a varying degree and more in the upper

than in the lower arch; secondly, that well-developed arches showed little, if any, permanent space loss following later extractions. But it was my impression that even when there was no obvious imbrication there was a tendency to a "tightness" between the teeth, especially the premolars and first permanent molars, which might predispose to interstitial caries. Even a reduction of $\frac{1}{10}$ mm. would make a difference in the pressure at the contact point. As to the extent and area of the changes, each case behaved individually and it was clear that to apply the result of a statistical analysis to any one child would lead to many errors.

It was, therefore, extremely interesting to find that Mr. Healy (who had no preconceived ideas concerning the material as he has no connexion with dentistry) had come to the conclusion from the measurements that it would be useless to evaluate equally the changes occurring in all the material. He has given these figures, but in addition he has shown on graphs the changes in the individual cases where the extractions occurred before the eruption of the first permanent molars. To show more clearly where and when these changes occurred, he graphed both segments of each quadrant as well as the totals for each quadrant as the totals did not show clearly the changes which actually occurred. When measuring the models I had noticed that the addition of the inner to the outer measurement at the period of greatest space reduction obscured this reduction, because at the same time that the space loss was reducing the outer segment measurement the normal expansion in the incisor region during the change from the deciduous to permanent teeth was increasing the inner segment measurement.

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STATISTICAL APPENDIX

(*M. J. R. Healy*)

It will be readily appreciated from Miss Clinch's paper that the material available for analysis was extremely heterogeneous. Not unnaturally, no two cases agreed in the particular teeth extracted and in the age at which extractions took place. On examination, however, it appeared that the cases in which extractions had taken place before the eruption of the 6's showed some degree of similarity, and the detailed comments which follow are mainly concerned with comparisons between these "early" extraction cases and the control series with no extractions.

1. Patterns of Change in the Measurements.—Graphs showing the measurements on selected control and "early" extraction cases are given in *Figs.* 5–10. In the extraction group, the nature of all extractions and the ages at which they took place are given on the graphs, and the age of eruption of the 6's is indicated by a small vertical bar. The four segments will be described separately.

a. Upper Jaw, Incisor-canine Segment.—In the control cases, this measurement undergoes a marked increase, usually extending over a period of 2–3 years, and this is sometimes followed by a slight decrease. The average age at which the highest measurement is attained is about 9 years, but the actual age varies in individual subjects from 7 to 13 years.

The early extraction cases follow a very similar pattern. When extraction was unilateral, the increase tended to be slightly larger on the extraction side; the average difference between the two sides in 8 cases was $0{\cdot}46 \pm 0{\cdot}12$ mm.

b. Upper Jaw, Premolar-molar Segment.—The control measurements in this segment tend to decrease slightly over the period considered, but the change is gradual and rarely

exceeds 3 mm. The early extraction group presents a very different picture. Here extraction is usually followed immediately by a substantial decrease in the measurement ranging from 3 mm. to as much as 9 mm., often followed by a partial recovery.

level of about 7 per cent. As in the upper jaw, early extraction appears to have little effect.

d. Lower Jaw, Premolar-molar Segment.—Again the general pattern resembles that in the upper jaw, the decrease and the control measurements being now rather larger as a

Table 1.—Maximum Increases and Decreases, in mm.

		No. of Cases	*Mean*	*Standard Deviation*
Incisor-canine segment (increase)	*Upper jaw–controls*	11	3·64 ± 0·22	± 0·74
	extractions: early	10	3·92 ± 0·28	± 0·90
	others	14	3·86 ± 0·14	± 0·54
	Lower jaw–controls	11	2·42 ± 0·18	± 0·61
	extractions: early	11	2·62 ± 0·21	± 0·68
	others	12	2·92 ± 0·23	± 0·80
Premolar-molar segment (decrease)	*Upper jaw–controls*	11	2·72 ± 0·29	± 0·92
	extractions: early	10	6·18 ± 0·70	± 2·21
	others	14	3·52 ± 0·36	± 1·36
	Lower jaw–controls	11	3·10 ± 0·24	± 0·79
	extractions: early	11	3·93 ± 0·37	± 1·23
	others	12	3·99 ± 0·21	± 0·73

Certain points of detail may be seen on the graphs (*Fig.* 6). Thus *Case* 20 shows a decrease of 8 mm. on the side on which |E was extracted, while the other side shows a decrease of 5 mm. at a later age. On the other hand *Case* 42, with early extraction of |DE, shows only a small decrease on the opposite side. In *Case* 95, the early extraction was of |D; the late decrease of about 6 mm. on the opposite side may have been associated with the extraction of both lower 6's. An interesting subject is control *Case* 57 which had a large decrease (7·9 mm.) on the right side. This seems to have been due to 6| impacting on and knocking out E| between the ages of 8 and 9, a phenomenon which has mimicked the effect of an early extraction.

c. Lower Jaw, Incisor-canine Segment.—In the controls, the pattern is similar to that in the upper jaw with an early increase in the measurement, but the increase is usually smaller and less abrupt. There is some indication that the increases in the two jaws of the same individual are correlated, the correlation coefficient of +0·58 giving a significance

rule. There appears to be no relation between the magnitude of the decreases in the two jaws. Early extraction intensifies the decrease, but the effect is less marked than in the upper jaw.

2. Metrical Comparisons.—The increase or decrease in a particular segment was measured as the difference between the largest and smallest measurements recorded in that segment. In the controls (except for *Case* 57) and in cases with bilateral early extractions, the two sides of the jaw were averaged. The aberrant value for the upper premolar-molar segment in *Case* 57 was omitted.

The mean increases and decreases for the controls, "early" extractions and other extractions are given in *Table* 1. Standard deviations and standard errors of the means are also given.

The actual distributions whose means and standard deviations are given in *Table* 1 are illustrated in *Fig.* 13. Here each square represents one case, and early extractions are distinguished by shading.

3. Relations between Space Loss and Tooth-size.—The relation between total space loss

and initial spacing in the extraction cases is illustrated in *Fig.* 2. Here, total space loss is measured by the decrease between the first and last measurement recorded, and initial spacing by the difference between the initial measurement of the arch and the sum of the breadths of the 5 deciduous teeth. As before, means of right and left sides were taken for cases with bilateral extractions. On 23 cases, significant correlations ($P < 0.05$) were found in each jaw, but the correlation was positive ($+0.44$) in the lower jaw and negative (-0.44) in the upper.

Total space loss was also correlated with the total breadth of the 5 permanent teeth, as shown in *Fig.* 3. The correlations were -0.2[illegible] in the upper jaw and -0.44 in the lower, the latter being significant ($P < 0.05$).

4. Measuring Errors.—In order to assess the reproducibility of the measurements, these were repeated after a considerable interval on the arches from 6 subjects and on the teeth for 5 subjects.

The standard deviations of *differences* between repeat measurements were:—

Teeth:	Single tooth	± 0.19 mm.
	Sum of 5 teeth	± 0.55 mm.
Arches:	One segment	± 0.28 mm.
	Sum of 2 segments	± 0.41 mm.

DISCUSSION

Mr. B. C. Leighton said he must congratulate Miss Clinch on the persistence and tenacity which must have been necessary to follow up such a high proportion of cases over so long a period. A wastage of 47 cases out of 106 in 11 years seemed to him very good going. His experience was that the wastage could have been expected to be considerably higher, particularly as he gathered that the patients in question had had no expectation of treatment.

There were quite a lot of difficulties in handling a longitudinal survey over such a long period of time. There was the loss of patients, the conflict with school, the conflict with parents, and the cost of fares. Finally, the ethical problem must have arisen of what to do if one saw something which needed treatment. He found it very difficult to decide whether to tell the parents that some treatment was needed and so destroy the research, or whether to say nothing and feel rather guilty. In quite a lot of cases the whole thing had been solved because he had learnt that the patient was under someone else's care for orthodontic treatment, and as it had appeared that nothing was being done he had not had to worry.

He said he had been surprised to hear that 7 of the patients were lost through illness, and asked whether that meant they had been ill for the whole period, or that they had just missed one of the visits?

He was glad that Miss Clinch had stressed the value of longitudinal surveys, as opposed to transverse ones. As she had said, transverse surveys could be very deceiving, as also could surveys which were insufficiently longitudinal. Many of the findings that Miss Clinch had spoken of confirmed impressions that had been gained in clinical practice—the permanent loss of space was more likely if the extractions were performed early, and greater space loss was produced by the extraction of the second molars than of teeth further forward in the arch. He thought the observation that no loss of space followed in the lower arch in a prenormal case was an important one, as that might save the fitting of quite unnecessary space maintainers.

Mr. Leighton then asked Miss Clinch if any X-rays had been taken of the patients she had mentioned. It seemed to him that the loss of space was sometimes linked with the degree of curvature of the roots of the molars, and that in turn might be linked with the degree of crowding. In smaller arches the roots were more likely to be curved, and in well spaced arches, particularly in prenormal cases, in the lower arch the roots were more likely to be straight. He would also like to ask Miss Clinch about the first case she had shown, regarding which she had said that the space loss of the second deciduous molar was regained by movement of the lower permanent molar. Was there any imbrication of the lower incisors? Miss Clinch had mentioned that the midline had deviated, and he wondered whether crowding in the incisor region had influenced that deviation.

He would like to mention, too, that it had appeared to him, on looking at the models on the screen, that the first molars on the other side of the arch changed in occlusion, in the opposite way and at the same time as the ones that Miss Clinch had been considering. Was it possible that some of the changes in that molar relationship had been mainly due to a change in position of the mandible in occlusion? He wondered, too, if he could ask how Miss Clinch had decided whether the molar had moved forward towards the incisor segment, had fallen back, or had failed to move forward.

Lastly, he would mention muscular environment, particularly in the incisor region. He would calculate that the research, which had extended over a period of 11 years, must have been started perhaps somewhere about 1946, so it was unlikely that Miss Clinch would be able to tell the meeting very much about muscular environment. He wondered, however, whether Miss Clinch could say anything about the environment, particularly the behaviour of the lower lip, in those cases where space had been lost to the front of the lower arch, in the later stages of observation.

Concluding, Mr. Leighton said he would once again congratulate Miss Clinch on a very useful paper, and one which he thought would help in the decision of which cases were going to lose spaces, and which cases were going to need some sort of space maintenance.

Miss L. M. Clinch said Mr. Leighton had asked how people had been persuaded not to go and have treatment when she had wanted to see them, but she was now suffering from having to treat some of them at a much later stage than she would like. She was, however, doing her best to rectify it.

Regarding the loss of patients through illness, Miss Clinch said that there had been a polio epidemic, and two of the children had died, the others being out of action for quite a few years. She had not had the heart to harass them afterwards.

No X-rays had been taken of the cases. Personally she found it very difficult to tell from X-rays much more than what teeth were present.

There had been no imbrication of the lower incisors in the molar rotation case. The occlusion on the other side did not, however, switch round. She had been under the impression initially that it had, but that appearance had been caused by the fact that the lower E was retained, keeping the 6 back, whereas the other E was shed and the upper 6 had moved forward. As soon, however, as the lower E had been shed, the lower 6 had automatically come forward into occlusion. There had not been a change in the mandibular position.

Concerning muscular environment, not even in the 14-year-olds did Miss Clinch know what the muscular environment was. The control cases, it must be remembered, were not necessarily good occlusions. They were completely random, therefore presumably the muscular environment in the control cases would have been just as variable as it had been in the others. Possibly, of course, muscular environment would have had more effect on the break in the arch, but Miss Clinch had not noticed any muscular environment that could account for the differences in the migration of the teeth.

Before opening the meeting for general discussion the *Chairman* asked Miss Clinch if she did not agree that a lower molar which was moving forwards might not easily encourage a forward movement of upper teeth whether or not the upper arch was broken.

Miss L. M. Clinch replied that in an unbroken upper arch she would not have thought so.

The Chairman opened the meeting for general discussion.

Mr. E. K. Breakspear said he would also like to congratulate Miss Clinch on her very remarkable and persistent study. He thought he detected a slight indication of a "cold war" between the cross-sectionalists and the longitudinalists, but he hoped that was not so, because he felt that the two types of study were complementary, and that each one helped the other. An idea begun by a paper such as had been read, led one to look at something else in a cross-sectional study, and that in turn threw more light on the longitudinal.

He would like to make three comments. First, he thought he had heard Miss Clinch say that in 10 out of the 29 cases there had been very little, if any, final space loss in spite of the fact that both D's and E's had been extracted. He thought it was a matter of some importance whether adjacent D's and E's had been extracted together, or whether it had been separate D's and E's, because he had a theory. He was at that moment trying to throw some light upon whether, when the D and E were extracted together, the tongue could get into the space as a space retainer more often than if the teeth were extracted one at a time, and the others "stayed put". He would like comments on that. He might have misinterpreted what Miss Clinch had said.

The second point was the question of the midline. He was, as perhaps some of those present knew, very keen on measuring unilateral extraction cases, which seemed to him to be relatively uncomplicated. He was not at all worried about the midline. Lundström had raised this point with him before, but he still could not see why, if a midline moved, that invalidated the measurement of the loss of space at the point at which it was measured. He would have thought midline movement was one of a number of possible secondary effects which did not make any difference to the basic measurement at the site of the extraction.

The third point was about the cuspal lock. He had been interested to hear that Miss Clinch found that in some cases the cuspal lock had prevented migration, and in other cases it had not. He wondered if there was a teeth-together swallow in the cases where migration had not occurred, which meant that the teeth had been together for a larger portion of the child's waking life.

Finally, Miss Clinch had said that the cases she had mentioned had been individual cases, and that she could not really tell what was going to happen altogether, but he also believed that all were very complex cases. Each case probably had at least half a dozen factors at work. He believed it would be possible, when enough was known eventually to enable all the factors to be tracked down, to make some sort of accurate picture, and in 20 years' time it would be possible to predict with much more accuracy than was possible at present.

Miss L. M. Clinch said she did not think there was a "cold war" between the cross-sectionalists and the longitudinalists. She thought the cross-section was less easy to apply and the results of a cross-sectional survey far more difficult to assess. A longitudinal survey was easier to apply on an individual, as it was possible to see what had been happening right through a case, and one was more likely to be able to see the same thing happening to another individual; but both types of investigation were bound to be useful.

With regard to the extraction of adjacent D's and E's, Miss Clinch said she was unable to give exact information. There had, however, been only 29 cases altogether. Dividing those into bilateral and unilateral extraction, sometimes of lower, lower and upper, teeth in opposite quadrants, it might have been just one or two cases of each at the end.

It had been said that if the midline were to move, it would not matter. Lundström had brought up the matter of the midline, and whether it was legitimate to compare one side with another—an extraction side with a non-extraction side. Miss Clinch thought it did matter, because if, for example, a lower midline moved and then stayed static, one could not have a normal occlusion of molars. All the extra spaces in the lower canine premolar region on one side would be used up by that shift of midline, and therefore the second molars would not occlude anatomically correctly. Surely it made a difference, although it might not be in the actual space loss but in the occlusion? That could, however, he talked over later.

In answer to the question about cuspal locks, and whether there had been a difference in swallowing habit in the cases in which the cuspal lock had kept the space open and those in which it had not, Miss Clinch said she was delighted to be able to say that in the same case the

cuspal lock had kept the space open on one side and not on the other. (Laughter.)

Miss Clinch said she thought there was no doubt, even though it was very difficult to get anything definite out of those cases, that the more one worked on this subject the more likely one was to be able to predict the result. Even now one was more often able to predict correctly which cases needed space retainers and which cases were likely to suffer from extractions and which were not. There was no doubt that, whether cross-section or longitudinal section, the more one learnt the more one would be able to apply later in the treatment of individual cases.

Mr. E. K. Breakspear, speaking again on the subject of the midline, said he thought there was a difference between secondary movement of the midline which might very well be the result of the extraction, leaving the teeth behind the extraction unaffected except by their own migration; and what might be called a primary deviation of the midline due to some other cause, where the whole arch was changed. He could quite see Miss Clinch's point, and he was glad she had mentioned it. If the whole of the arch was in a different relation from the normal, then of course the effects were going to be different on the two different sides; but if the back teeth were more or less normal, and there was simply a movement of the front teeth, he thought that would not affect the space measurement. They would probably, however, resolve the difference when they came to explain exactly what they meant.

The Chairman, in expressing the thanks of the meeting, said the ability to undertake longitudinal studies, as Mr. Leighton had said, required a tenacity and a persistence which were given to very few.

He had been told that women were able to withstand the buffetings of misfortune better than men, and longitudinal studies provided many disappointments.

The Society was fortunate to have Miss Clinch as a member. She combined the persistence of her sex with the tenacity of her race to deal with problems with which men had so little patience.

He was sure that all those present would wish him to express to Miss Clinch, Mr. Healy, and Mr. Leighton the thanks of the Society which would be shown in the usual way. (Applause.)

The Chairman then declared the meeting closed.

ABSTRACTS FROM OTHER JOURNALS

Ulceration of the Oral Mucosa

The author, a medically-qualified dentist, believes that the diagnosis and largely the treatment of mouth ulcers are the province of the dentist, because he alone has had adequate training in the surgical pathology of the mouth. He goes so far as to say that he sees no reason why the dentist should not diagnose and treat a case of simple hypochromic anæmia requiring only the administration of iron. In his experience a proportion of mouth ulceration cases is associated with this form of anæmia.

The causes of oral ulcers are listed as being due to one or more of the following: trauma, vitamin deficiency, allergy, nervous factors, blood diseases, specific organisms, tumours, and to unknown causes. Dental treatment can cause ulceration of the oral mucosa and a bad case is cited where application of silver nitrate to a sensitive exposed root surface led to ulceration. The diagnosis is to include, apart from a careful history-making, clinical examination, blood and bacterial investigations, allergy tests, and biopsy.

Treatment is directed at cleaning up the mouth when practicable, elimination of trauma, correction of food deficiencies and combating specific organisms. Some of the measures are instituted with the help of the physician, and special help is sought in cases of allergy, blood diseases, and tumours.—FLEMING, W. E. (1958), *Aust. dent. J.*, **3**, 363.

Improving the Alveolar Ridge for Dentures

A denture is only as good as its foundation, and in such cases as the following, surgical alteration of the mouth is necessary for successful denture planning:—

Enlarged tuberosities; redundant mass of soft tissue on the crest of either alveolar ridge; hyperplastic soft tissue in sulcus consequent upon ill-fitting dentures; sharp irregular alveolar ridges; various forms of exostosis, torus palatinus, and torus mandibularis; sharp mylohyoid ridge or even its presence. A denture can be fitted much more deeply lingually if the ridge is removed; protruding maxilla; muscle attachment too near the alveolar ridge, or attachment or scars obliterating the sulcus; pathological conditions of tongue, palate, cheek, etc., whether benign or malignant; protruding mandible (prognathism should be reduced before tooth-extraction); mental nerve too near surface.

Most of these are mild operations which give great satisfaction to all concerned.—GOLDIN, H. (1958), *J. dent. Ass. S. Afr.*, **13**, 428.